VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

Solutions of Archive - JEE Main & Advanced

Stoichiometry-I	Class - XI | Chemistry

JEE Main 2021

1.(2) Molarity $= \dfrac{n_{solute}}{(V_{solution})_L} = \dfrac{4.5/90}{0.25} = 0.2 = 2\times10^{-1}$

2.(C) Mass of $CO_2 = 2.64g$

$n_{CO_2} = \dfrac{2.64}{44} = 0.06$, W of C $= 0.06\times10 = 0.72$ gms

$n_{H_2O} = \dfrac{1.08}{18} = 0.06$, $W_{H_2} = 0.06\times2 = 0.12$ gm

$\therefore$ Weight of oxygen in $C_xH_yO_z$

Total wt. = 1.08g

Weight of oxygen = 1.8 – 0.72 – 0.12 = 0.96 gm

% weight of oxygen $= \dfrac{0.96}{1.8}\times100 = 53.37$

3.(4) $\dfrac{1}{2}(\text{Meq. of } Na_2CO_3) = \text{Meq. of HCl}$

$\dfrac{1}{2}\left(\dfrac{W_{Na_2CO_3}}{53}\times10^3\right) = 0.1\times1.5$

$W_{Na_2CO_3} = 0.0159\text{gm}$

% of $Na_2CO_3 = \dfrac{0.0159}{0.4}\times100 = 3.97\% = 4\%$

4.(6) The volume of NaOH used is 4.4 ml as given in the question

meq of NaOH = meq of oxalic acid

$M\times4.4 = 1.25\times2\times10$; $M = \dfrac{1.25\times2\times10}{4.4} = \dfrac{25}{4.4} = 5.68\,\text{ml}$

So the answer will be 6

5.(8) Zeroes at the end or right of a number are significant, provided they are on the right side of the decimal point. For example, 0.200 g has three significant figures. But, if otherwise, the terminal zeroes are not significant if there is no decimal point. For example, 100 has only one significant figure, but 100. has three significant figures and 100.0 has four significant figures. Such numbers are better represented in scientific notation. We can express the number 100 as 1×10^2 for one significant figure, 1.0×10^2 for two significant figures and 1.00×10^2 for three significant figures.

6.(13) Mass of Na^+ per mL = 70 mg

Moles of Na^+ per mL $= \dfrac{70\times10^{-3}}{23}$ moles $= 3.04\times10^{-3}$ moles

So moles of $NaNO_3$ per mL = 3.04×10^{-3}

Thus moles of $NaNO_3$ per 50 mL $= 3.04\times10^{-3}\times50 = 0.152$

Mass of $NaNO_3 = 0.152\times85 = 12.92\,g \simeq 13\,g$

7.(525) $3Pb(NO_3)_2 + Cr_2(SO_4)_3 \rightarrow 3PbSO_4 \downarrow + 2Cr(NO_3)_3$

$n_{Pb(NO_3)_2} = 35 \times 0.15 = 5.25\,\text{m moles}$

$n_{Cr_2(SO_4)_3} = 20 \times 0.12 = 2.4\,\text{m moles}$

$Pb(NO_3)_2$ is limiting reagent.

$\therefore$ Number of m moles of Pb of SO_4 precipitated = 5.25 m moles

5.25×10^{-3} moles = 525×10^{-5} moles

8.(3) % of hydrogen in the organic compound $= \frac{2}{18} \times \frac{W_{H_2O}}{W_{\text{Organic compound}}} \times 100 = \frac{2}{18} \times \frac{210}{750} \times 100 = 3.11\%$

So the answer will be 3

9.(18) $C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$

Given mass of ethane $= 3\,g$

Number of moles of ethane $= \frac{3}{30} = 0.1$

1 mol of ethane produce $H_2O = 3$ moles

0.1 mol of ethane will produce $H_2O = 0.3$ moles

$= 0.3 \times 6.022 \times 10^{23}$ molecules $= 1.8066 \times 10^{23} = 18.066 \times 10^{22}$

So, $x = 18$

10.(5) Mass of 1 L of solution $= 1200\,\text{gm}\,(d \times v)$

Density of water = 1 g / ml

$\therefore$ Mass of solvent = 1000 gm $\quad \therefore$ Moles of solute $= \frac{200}{40} = 5 \quad \therefore$ Molality $= 5\,m$

11.(464)

$C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$

1 mole $C_4H_{10} \longrightarrow$ 5 mole H_2O

58 g $C_4H_{10} \longrightarrow$ 90 gm H_2O

$\left(\frac{58}{90}g\right)C_4H_{10} \longleftarrow$ 1 gm H_2O

$\left(\frac{58}{90} \times 72\right)g\ C_4H_{10} \longleftarrow 72$ gm $H_2O \quad \Rightarrow \quad 46.4$ g C_4H_{10}

12.(3) Zero at the end or right of a number are significant provided they are on the right side of the decimal point. So, number of significant figures in 0.00340 is 3.

13.(4) $M = \frac{\text{mole}}{\text{vol}(L)} = \frac{0.72}{180} = 4 \times 10^{-3} M$

14.(226)

	HCl	+	NaOH	$\longrightarrow$	$NaCl + H_2O$
moles	$\frac{500 \times 1}{1000} = 0.5$		$\frac{250 \times 0.5}{1000}$ 0.125		
mole left	0.375				

$$(\text{Number of moles})\text{of HCl} = \frac{\text{No. of molecules}}{6.022\times10^{23}}$$

$$\text{Number of molecules} = 0.375\times6.022\times10^{23} = 225.8\times10^{21}$$

15.(1) Let say, $x + y = 4$ ....(1)

Equimolar means $\frac{x}{40} = \frac{y}{106} \Rightarrow y = \frac{106}{40}x$

So using equation (1)

$x + \frac{106}{40}y = 4$; $x + 2.065x = 4$

$3.65x = 4$; $x = 1.096\,\text{gm}$

$x = 1$ (approx)

16.(50) Molarity of $Na^{+} = \frac{3.45\times1000}{M_2\times100}$

$$M_{Na^+} = \frac{3.45\times1000}{23\times100} \Rightarrow M_{Na^+} = 1.5$$

$$Na_3PO_4 \longrightarrow 3Na^{+} + PO_4^{3-}$$

$$M_{Na_3PO_4} = 0.5\text{ M} = 50\times10^{-2}\text{mol / litre}$$

17.(2) $N = N_A\left[\frac{w}{M^\circ}\right] = 6.02\times10^{23}\left[\frac{8}{23}\right] = 2\times10^{23} \Rightarrow x = 2$

18.(64) Moles of $CuSO_4.5H_2O = \frac{80}{249.54} = 0.32$ [in 5 L soltuion]

$$[CuSO_4] = \frac{0.32}{5} = \frac{320}{5}\times10^{-3} = 64\times10^{-3}M$$

19.(13) $Na_2O + H_2O \longrightarrow 2NaOH$

Mass of NaOH $= \frac{80\times20}{62} = 25.806\text{gm}$

$$M_{NaOH} = \frac{25.806\times1000}{40\times500} = 1.290 = 12.90\times10^{-1} \approx 13$$

20.(3) 1000 kg solvent has 3.3 moles of KCl

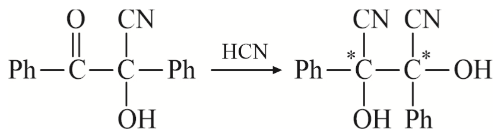
1000 kg solvent $\rightarrow 3.3\times74.5$ gm KCl $AgNO_3 + 2NH_3 \rightleftharpoons \left[Ag(NH_3)_2\right]^{+}$

Weight of solution $= \frac{1245.85}{1.2}$ ml

Volume of solution $= \frac{1245.85}{1.2}$ ml

So molarity $= \frac{3.3\times1.2}{1245.85}\times1000 = 3.17$

JEE Main 2022

1.(3) 

Total 3 stereoisomers (d and l form isomer + 1-meso form isomers)

2.(3) Moles of Hydrogen $= \frac{1.344}{22400} = 6 \times 10^{-5}$ moles

Moles of Compound $= \frac{1.84 \times 10^{-3}}{92} = 2 \times 10^{-5}$

No. of OH group $= \frac{6 \times 10^{-5}}{2 \times 10^{-5}} = 3$

3 alcoholic hydrogen.

3.(B) $(n + \ell)$ rule

$A = 3 + 2 = 5$; $B = 4 + 1 = 5$; $C = 4 + 2 = 6$; $D = 3 + 1 = 4$

$D < A < B < C$

4.(C) 3 mole KNO_3 = 4 mole HNO_3

$\frac{110}{101}$ mole $KNO_3 = \frac{4}{3} \times \frac{110}{101}$ mole HNO_3

Mass of $HNO_3 = \frac{4}{3} \times \frac{110}{101} \times 63 = 91.485\,g$

5.(C) Number of moles of $N_2 = \frac{20}{28} = 0.71$ moles

Number of moles of $H_2 = \frac{5}{2} = 2.5$ moles

$N_2 \; + \; 3H_2 \longrightarrow 2NH_3$

1 mole 3 mole 2 mole

0.71 mole 2.5 mole ?

1 mole of N_2 react with 3 moles of H_2

0.71 mole .... $3 \times 0.71 = 2.13$ mole of H_2

Amount of Hydrogen in reaction mixture is –2.5 moles (mean in excess). So limiting reagent is N_2.

1 mole of N_2 from 2 moles of NH_3

0.71 mole .... $2 \times 0.71 = 1.42$ mole of NH_3

6.(25) $H_2SO_4 \Rightarrow 2L, 0.2\,M \Rightarrow 0.4$ moles

$NaOH \Rightarrow 2L, 0.1\,M \Rightarrow 0.2$ moles

$H_2SO_4 \; + \; 2NaOH \longrightarrow Na_2SO_4 \; + \; 2H_2O$

0.4 moles 0.2 moles

(L. R)

Moles of Na_2SO_4 formed $= 0.1$ mole

$[Na_2SO_4] = \frac{0.1}{4} = 0.025 = 25$ millimolar

7.(46) $0.492\,g$ of $C_xH_yO_z$

Gives 0.7938 g $CO_2 = 0.018$ moles

$0.4428\,g$ $H_2O = 0.0246$ moles

So moles of $C = 0.018 \Rightarrow 0.216\,g$

Moles of $H = 0.049 \Rightarrow 0.049\,g$

$\therefore$ weight of Oxygen $= 0.492 - 0.216 - 0.049 = 0.227\,g$

% of Oxygen $= \frac{0.227}{0.492} \times 100 = 46$ (approx.)

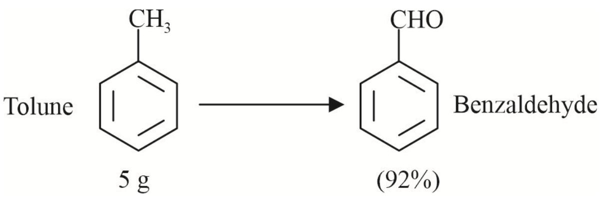
8.(2) $\underset{1\,mol}{X} + \underset{1\,mol}{Y} + \underset{0.05\,mol}{3Z} \rightleftharpoons XYZ_3$

Z is LR.

$\frac{0.05}{3} = 1$ mole of XYZ_3

Mass of $XYZ_3 = \frac{0.05}{3} \times (10 + 20 + 30 \times 3) = 2g$

9.(530)



No. of moles of Tolune $= \frac{5}{92}$

No. of moles of Benzaldehyde $= \frac{5}{92} \times \frac{92}{100} = \frac{5}{100}$

Mass of Benzaldehyde $= \frac{5}{100} \times 106 = 530 \times 10^{-2}\,g$

10.(1) Number of meq of $H_2SO_4 = 100 \times 0.1 \times 2 = 20\,meq$

Number of meq of $NaOH = 50 \times 0.1 = 5\,meq$

Number of meq of H_2SO_4 left $= 20 - 5 = 15\,meq$

Normality $= \frac{15}{150} = 0.1N = 1 \times 10^{-1}N$

For a real gas at a high pressure

11.(30) $n_{SO_3H} = 1 \times \frac{60}{100}$

$n_{phenol} = \frac{60}{100} \times \frac{50}{100} = \frac{30}{100} \times 100 = 30\%$

12.(B) Mol. weight of Glucose $(C_6H_{12}O_6) = 180\,g/mol$

Mass of carbon (in 250 gm solution) $= 250 \times \frac{10.8}{100} = 27\,gm$

$\therefore$ 72 gm of carbon is present in = 180 gm of glucose

$\therefore$ 27 gm of carbon will be present in $= 27 \times \frac{180}{72} = 67.5\,gm$

Mass of solvent = (250 – 67.5) = 182.5 gm

Molality $= \frac{(Moles)_{solute}}{(Mass\ of\ solvent)(kg)} = \left(\frac{67.5}{180}\right) \times \frac{1000}{182.5} = 2.055 \cong 2.06$

13.(3) $CH_3CH_2MgBr + CH_3OH \longrightarrow C_2H_6(g) + CH_3OMgBr$

Volume of ethane = 2.24 ml

moles of ethane $= \frac{2.24}{22400} = \frac{1}{10^4}$

Mass of ethane $\frac{W}{30} = \frac{1}{10^4}$

$W = \frac{30}{10^4} gm \quad \Rightarrow \quad W = \frac{30 \times 1000}{10^4} mg \quad \Rightarrow \quad W = 3\,mg$

14.(C) Hemoglobin contains 0.34% of iron by mass, it means 100g of Hemoglobin has 0.34g of Fe.
So, mass of iron in 3.3g of Hemoglobin is

$\Rightarrow \quad \frac{0.34}{100} \times 3.3 \quad \Rightarrow \quad 0.011\,g$

moles of iron $= \frac{0.011g}{56\,g/mole} \quad \Rightarrow \quad 0.000196\ \textit{mole} \simeq \textit{0.0002 mole}$

number of Fe atoms $= 0.0002 \times 6.02 \times 10^{23} = 1.21 \times 12^{20}$ atoms of Fe

15.(54) 800 ml 0.5 M HNO_3

m mole = 800 × 0.5

m mole = 400 of HNO_3

volume reduced to 400 ml after heating.

No. of m mole of HNO_3 skip of HNO_3 mole $= \frac{11.5}{63} = 182.5$

m mole of HNO_3 = 400 – 182.5 = 217.5

$M = \frac{217.5}{400} = \frac{54}{100} = 54 \times 10^{-2}$

16.(24) $48 = \frac{\text{mass of chlorophyll (mg)}}{2000} \times 10^6$

Mass of chlorophyll (mg) $= \frac{48 \times 2}{10^3}$

Mole of mg $= \frac{48 \times 2}{10^3 \times 24} = \frac{4}{10^3} \times 6.022 \times 10^{23} = 4 \times 6.022 \times 10^{20} = 24 \times 10^{20}$

17.(46) $N_2 + 3H_2 \longrightarrow 2NH_3$

N_2	$3H_2$	$2NH_3$
56L	excess	–
–10L	–30L	+20L
46L		20L

18.(C) Let $n(SO_2Cl_2) = x$ moles

$\therefore \quad n(H_2SO_4) = x,\ n(HCl) = 2x \quad \Rightarrow \quad n(H^+) = 4x$

For Neutralisation

$\Rightarrow \quad n(H^+) = n(OH^-) \quad \Rightarrow \quad 4x = 16 \quad \Rightarrow \quad x = 4$

19.(B) In multiplications and division, the result must be reported with no more significant-figures as in the measurement with the few significant figures.

20.(C) Mole of $Fe_3O_4 = \frac{4.640 \times 1000}{232}$

Mole of Fe formed $= 3 \times \frac{4.640 \times 1000}{232}$

Mass of Fe formed $= 3 \times \frac{4.640 \times 1000}{232} \times 56 = 3360gm$

Mole of CO $= \frac{2.520 \times 1000}{28}$

Mole of Fe formed $= \frac{3}{4 \times}\frac{2.520 \times 1000}{28}$

Mass of Fe formed $= \frac{3}{4} \times \frac{2.52 \times 1000}{28} \times 56 = 3780\,gm$

Fe_3O_4 is limiting reagent.

21.(D)

	H	C	N
% composition	8.7	74	17.3
Atomic mass	1	12	14
Gram-atom	$\frac{8.7}{1} = 8.7$	$\frac{74}{12} = 6.16$	$\frac{17.3}{14} = 1.23$
Simple ratio	$\frac{8.7}{1.23} = 7.07$	$\frac{6.16}{1.23} = 5$	$\frac{1.23}{1.23} = 1$

Empirical formula $= C_5H_7N_1$

Empirical formula mass $= 12 \times 5 + 1 \times 7 + 14 \times 1 = 81$

Molecular formula mass = 162

$n = \frac{162}{81} = 2$

Molecular formula $= C_5H_7N_1 \times 2 = C_{10}H_{14}N_2$

22.(2) First find % like $H = \frac{7.5}{116} = 6.4\%$; $O = \frac{60}{116} = 51\%$; $C = \frac{48.5}{116} = 42\%$

Now find out e. f.

$H = \frac{6.4}{1} = 6.4 \quad \Rightarrow \quad \frac{6.4}{3.2} = 2$

$O = \frac{51}{16} = 3.2 \quad \Rightarrow \quad \frac{3.2}{3.2} = 1$

$C = 42 = 3.5 \quad \Rightarrow \quad \frac{3.5}{3.2} = 1$

CH_2O

So possible formula will be A, B

23.(2) Let Atomic Mass of A = a

Atomic Mass of B = b

Given that A_2B & AB_3 weigh equal, so

Mass of $A_2B = 0.15(2a + b)$

Mass of $AB_3 = 0.15(a + 3b)$

$\Rightarrow \quad 0.15(2a + b) = 0.15(a + 3b) \quad \Rightarrow \quad a = 2b$

24.(A) Molality does not depend on temperature

25.(C) $M = 10\frac{xd}{M_0} = \frac{10 \times 35 \times 1.46}{36.5} = 14$

26.(225)

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O\left(\frac{81}{18}\right)\text{moles}$$

Moles of CH_4 required $= \frac{1}{2}\left(\frac{81}{18}\right) = 2.25\,\text{moles} = 225 \times 10^{-2}\,\text{moles}$

27.(143)

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

	CH_4	+	$2O_2$	$\longrightarrow$	CO_2	+	$2H_2O$
Given	100 g		208 g				
Moles	$\frac{100}{16} = 6.25$		$\frac{208}{32} = 6.5$				

Oxygen is limiting reagent

Moles of $CO_2 = 3.25$

Mass of $CO_2 = 3.25 \times 144 = 143\,\text{gm}$

28.(5418)

681 g of $C_7H_5N_3O_6$

Molar mass of $C_7H_5 - N_3O_6 = 227\,g$

So number of moles of N-atm in compound $= 3 \times \frac{681}{227} = 9\,\text{mol}$

So number of N-atoms $= 9 \times 6.02 \times 10^{23} = 54.18 \times 10^{23} = 5418 \times 10^{21}$

So $x \times 10^{21} = 5418 \times 10^{21} \quad \therefore \quad x = 5418$

29.(0) Initial m mole = 0.02

In 50% solution m mole = 0.01

Total m mole in final solution = 0.01 + 0.01 = 0.02 = 0.00002 × 10^3 m mol

30.(1143)

$$CH_2 = CH - CH_2 - CH_2 - CH_3 + Br_2 \xrightarrow[CCl_4]{} \underset{\substack{|\\Br}}{C}H_2 - \overset{\substack{Br\\|}}{C}H - CH_2 - CH_2 - CH_3$$

70g   160g

$\therefore$ 70 g pent-1-ene reacts with 160 g of Br_2

So 5g pent-1-ene reacts with $\frac{160}{70} \times 5 = 11.428\,g$ of $Br_2 = 1142.8 \times 10^{-2}\,g \simeq 1143$

31.(3) Millimoles of $OH^- = 30 \times 0.05 \times 2 = 3$

Thus basicity of acid would be = 3

Millimoles of $H^+ = 10 \times 0.1 \times 3 = 3$

32.(63) m_{eq} of NaOH used $= 30 \times 0.25 = 7.5$

m_{eq} of H_2SO_4 used = 7.5

m_{eq} of NH_3 reacted = 7.5

mmoles of $NH_3 = 7.5$

mmoles of 'N' atom = 7.5

mass of 'N' = $7.5 \times 10^{-3} \times 14 = 105 \times 10^{-3} = 0.105$ grams

% of 'N' $= \frac{0.105}{0.166} \times 100 = 63.25 \approx 63\%$

33. (C) $C_{15}H_{30} + \frac{45}{2}O_2 \rightarrow 15CO_2 + 15H_2O$

Mass of fuel = 0.756 × 1000 g ($\because$ mass = density $\times$volume)

Number of moles of fuel $= \frac{0.756 \times 1000}{210}$ ($\because$ mol. wt. of fuel = 210)

Mass of oxygen $= \frac{0.756 \times 1000}{210} \times \frac{45}{2} \times 32 = 2592\,g$ (as 1 mole of fuel requires $\frac{45}{2}$ moles of oxygen)

Mass of $CO_2 = \frac{0.756 \times 1000}{210} \times 15 \times 44 = 2376\,g$ (as 1 mole of fuel produces 15 moles CO_2)

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Atomic Structure	Class - XI | Chemistry

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1.(2)

	$H^+(p)$	Li^{3+}
	mass = x	8.3x
	KE = eV	3eV
$\left(\frac{h}{\sqrt{2m\,KE}}\right)$	$\lambda = \frac{h}{\sqrt{2x(eV)}}$	$\frac{h}{\sqrt{2(8.3x)(3eV)}}$

$$\Rightarrow \frac{\lambda_{Li^{3+}}}{\lambda_p} = \frac{1}{5} = 2\times10^{-1}$$

2.(D) $f = \frac{1}{T} = \frac{V}{2\pi r}$

$$V \propto \frac{z}{n},\quad r \propto \frac{n^2}{z} \qquad \therefore \quad f \propto \frac{(z/n)}{(n^2/z)} \propto \frac{z^2}{n^3}$$

3.(A) Radial nodes $= n-1-l = 3-1-0 = 2$

Thus answer would be (A).

4.(181)

$$\lambda = 663\,nm\,; \qquad E = \frac{6.63\times10^{-34}\times3\times10^8}{663\times10^{-9}}\times\frac{6.02\times10^{23}}{1000} = 0.1806\times10^3 = 180.6$$

So the answer will be 181 after rounding off.

5.(D) Radial node $= 2 = (n-l-1)$

Angular node $= l = 2$

$n-2-1 = 2$

$n = 5$

6.(1) $m = 10\,g$ $\qquad v = 90\,ms^{-1}$

$\Delta v = 5\%$ of v $\qquad \Delta x = ?$

$$= \frac{5}{100}\times90 = 4.5\,m/s$$

$$\Delta x\cdot\Delta v = \frac{h}{4\pi m} \quad\Rightarrow\quad \Delta x\times4.5 = \frac{6.63\times10^{-34}}{4\times3.14\times10\times10^{-3}}$$

$$\Delta x = 1.17\times10^{-33}\,m \simeq 1\times10^{-33}\,m = x\times10^{-33}\,m \quad\Rightarrow\quad x = 1$$

7.(3) $n = 5 \qquad m_l = +2$

m can take values from $-l$ to $+l$

Possible orbital are :

(i) $n = 5,\ l = 2,\ m = +2$

(ii) $n = 5,\ l = 3,\ m = +2$

(iii) $n = 5,\ l = 4,\ m = +2$

8.(C) Bohr's theory accounts for stability of atom but is only applicable to single electron species (Li^+ is a multi electron species)

Bohr's theory is also unable to explain zeeman effect (splitting of spectral lines in presence of magnetic field).

9.(0) $n = 4 \quad m = -3 \quad \Rightarrow \quad 4f$

Number of radial node $= n - \ell - 1 = 4 - 3 - 1 = 0$

10.(9) $h\nu = h\nu_0 + K.E.$

$$K.E. = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{248 \times 10^{-9}} - 3 \times 1.6 \times 10^{-19}$$

$$= 0.080 \times 10^{-17} - 4.8 \times 10^{-19} = (8 - 48) \times 10^{-19} = 3.2 \times 10^{-19}$$

$$\lambda = \frac{h}{\sqrt{2mK.E.}} = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 3.2 \times 10^{-19}}} = \frac{6.63 \times 10^{-9}}{\sqrt{2 \times 3.2 \times 9.1}} = \frac{6.63 \times 10^{-9}}{\sqrt{58.24}} \frac{1}{2} = \frac{6.63 \times 10^{-9}}{7.631}$$

$$= 0.868 \times 10^{-9} = 8.68 \times 10^{-10} m = 8.68 Å$$

So the correct answer is 9

11.(B) Number of radial node $= n - l - 1$

Number of angular node $= l$

Ex $\rightarrow$ In 3s,

Number of angular node $= 0$

Number of radial node $= 3 - 0 - 1 = 0$

12.(A) Fact

13.(B) If the Thompson model of the atom was correct then in the gold foil experiment α-particles will pass through the gold foil, deflected by small angles with reduced speed.

14.(2) 1000 J in 10 sec.

Energy of 1 photon $\Rightarrow \dfrac{12,400}{4000} = 3.1 eV$

Let there be n photons in 1 second.

$E = nh\nu$

$(100 J)_{\text{in 1 second}} = n \times 3.1 \times 1.6 \times 10^{-19}$

$n = 20.1 \times 10^{19} \quad \Rightarrow \quad n = 2 \times 10^{20}$

As all photons will be able to eject electron from Na

15.(58) $\Delta x \cdot \Delta v = \dfrac{h}{4\pi m}$

$$\Delta v = \frac{0.02}{100} \times 5 \times 10^6 = 0.1 \times 10^4 = 1000 m/s$$

$$\therefore \quad \Delta x \cdot (1000) = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31}} \quad \Rightarrow \quad \Delta x = 0.58 \times 10^{-7} = 58 \times 10^{-9} = x \times 10^{-9}$$

Thus $x = 58$

16.(D) Spin only magnetic moments $= \sqrt{n(n+2)}$ B.M where n = number of unpaired electrons

For, Ti^{+3}, it is $\sqrt{3} = 1.73 BM$

For, V^{+2}, it is $\sqrt{15} = 3.87 BM$

For, Sc^{+3}, it is 0 BM

17.(12) $V = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^3$

No. of e^- in P orbitals $= 12$

18.(0) Electronic configuration for,

$Ga = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$

$Ga^+ = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

Valence electron of Ga is in S orbital.
Hence, azimuthal quantum number is 0.

19.(6) $\lambda = x \times 10^{-12}\,m \qquad v = 40\,kV$

$$\lambda = \frac{h}{\sqrt{2eVm}} = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.6 \times 10^{-19} \times 40 \times 10^3 \times 9.1 \times 10^{-31}}}$$

$$= \frac{6.6 \times 10^{-34}}{\sqrt{11648 \times 10^{-46}}} = \frac{6.6 \times 10^{-34}}{10.4 \times 10^{-23}} = \frac{6.6 \times 10^{-11}}{10.4} = 6.3 \times 10^{-12}\,m$$

Thus $x = 6$ (approx)

20.(2) $\frac{n}{t} = \frac{P}{E} = \frac{P}{hc/\lambda} = \frac{P\lambda}{hc} = \frac{39750 \times 10^{-9}}{19.86 \times 10^{-26}} = 2$ (approx.)

21.(0) $Zn^+ = 1s^2 2s^2 2p^6 3s^2 sp^6 3d^{10} 4s^1$

Outermost electron $= 4s^1$

$n = 4, \ell = 0, m = 0$

22.(A) $Eu = [Xe] 4f^7 6s^2$

$Eu^{2+} = [X_e] 4f^7$

23.(7) $Ge = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^2$

↓ ↓ ↓ ↓ ↓ ↓ ↓

$m_\ell = 0$ 1 1 1 1 1 1 1

(fully filled)

24.(50) $1\,mW = 10^{-3}\,W$ or $10^{-3}\,J/s$

In 1 second $\longrightarrow 10^{-3}\,J$

In 0.1 second $\longrightarrow 10^{-4}\,J$

$E = nh\nu$ or $\frac{nhc}{\lambda} = E$

$n \longrightarrow$ Number of photons emitted.

$$10^{-4} = \frac{n \times 6.63 \times 10^{-34} \times 3 \times 10^8}{1000 \times 10^{-9}} \quad \Rightarrow \quad n = 50 \times 10^{13} \quad \Rightarrow \quad n = 50$$

25.(3155)

$$mvr = \frac{nh}{2\pi}$$

$$r = \frac{nh}{2\pi mv}$$

Since, $mv^2 = \frac{kze^2}{r}$ ......(i)

Putting value of r in equation (i)

$$mv^2 = \frac{kze^2}{nh} \times 2\pi mv \quad \Rightarrow \quad v = \frac{kze^2 \times 2\pi}{nh}$$

$$K.E. = \frac{1}{2}mv^2 = \frac{1}{2}\frac{mk^2z^2e^4 4\pi^2}{n^2h^2}$$

$$r = \frac{n^2h^2}{4\pi^2 mkze^2}$$

For hydrogen atom, $a_0 = \frac{h^2}{4\pi^2 mke^2}$

Kinetic energy $= \frac{h^2}{xm a_0^2}$ (given in question)

Putting the value of K.E. and a_0.

We get $x = 32\pi^2 = 32 \times (3.14)^2 = 315.50$

So, value of 10x is 3155

26.(5) $E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{500 \times 10^{-9}}$

$E = 4 \times 10^{-19} J$

$W = h\nu_0 = 6.63 \times 10^{-34} \times 4.3 \times 10^{14}$

$W = 2.85 \times 10^{-19}$

$KE = \frac{1}{2}mv^2 = E - W$

$\Rightarrow \quad \frac{1}{2} \times 9 \times 10^{-31} \times v^2 = 4 \times 10^{-19} - 2.85 \times 10^{-19}$

$\Rightarrow \quad \frac{1}{2} \times 9 \times 10^{-31} \times v^2 = 1.15 \times 10^{-19} \quad \Rightarrow \quad v^2 \approx 0.25 \times 10^{12} \quad \Rightarrow \quad v \approx 5 \times 10^5 m/sec$

27.(C) $v = 2.18 \times 10^6 \frac{z}{n} m/sec$

$Z \downarrow \quad \Rightarrow \quad v \downarrow \quad \Rightarrow$ Statement-I : False

$n \downarrow \quad \Rightarrow \quad v \uparrow \quad \Rightarrow$ Statement-II : True

JEE Advanced 2021

1.(30) $\Delta P = \frac{h}{\lambda}$

$m \cdot \Delta V = \frac{h}{\lambda}$

$$\Delta V = \frac{h}{\lambda \cdot m} = \frac{6.6 \times 10^{-34} \times 6 \times 10^{23}}{330 \times 10^{-9} \times (4 \times 10^{-3})} = 0.3 \text{ m/sec} = 30 \text{ cm/sec}$$

JEE Main 2022

1.(548) $2 \times 52.9 \times 10^{-12} \times 9.1 \times 10^{-31} \Delta V = \dfrac{6.64 \times 10^{-34}}{4 \times 3.14}$

$$\Delta V = \frac{6.64 \times 10^{-34}}{4 \times 3.14 \times 2 \times 52.9 \times 10^{-12} \times 9.1 \times 10^{-31}} = \frac{6.64 \times}{12092.51} \times 10^{9}\, ms^{-1} = 548\, km\, s^{-1}$$

2.(2) Minimum energy required to escape $= 13.6\, eV = 2.18 \times 10^{-18} J$

Wavelength of the emitted $e^{-} = 3.3 \times 10^{-10} m$

As $\lambda = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mE}}$, E is K.E of the electron

$$E = \frac{h^2}{\lambda^2(2m)} = \frac{(6.626 \times 10^{-34})^2}{(3.3 \times 10^{-10})^2 (2 \times 9.1 \times 10^{-31})} = \frac{2}{9.1} \times 10^{-17} J = \frac{20}{9.1} \times 10^{-18} J = \underset{\text{(approx)}}{2.18 \times 10^{-18} J}$$

$E_{abs.} = E_{min} + K.E = 2(E_{min})$

3.(D) Atomic orbital is characterized by quantum number n, ℓ and m.

4.(2) Cation present in Fehling solution is Cu^{+}

$Cu^{+} : 3d^{9}$ configuration

3d

⇅	⇅	⇅	⇅	↑

Number of unpaired $e^{-s} = 1$

$\vec{\mu} = \sqrt{n(n+2)} = \sqrt{3}$ B.M. $= 1.73$BM

5.(A) Lower the value of $n+1$ for the orbital lower is the energy.
If $n+1$ value is same, orbital with lower value of 'n' is of lower energy.
$n = 3, \ell = 0, m = 0;\ n + l = 3$

6.(A) Both A and R are true and R is the correct explanation of A.
The energy of 2s-orbital of hydrogen is greater than that of 2s-orbitals of Li, as energy of Sub-shells in the same shell decreases with increase in the atomic number.

7.(1758)

$V_e = xV_n$

$\lambda_e = \lambda_n$

$\dfrac{h}{m_e V_e} = \dfrac{h}{m_n V_n}$

$m_e x V_n = m_n V_n$

$x = \dfrac{m_n}{m_e} = \dfrac{1.6 \times 10^{-27}}{9.1 \times 10^{-31}} = 1758$

8.(10) Maximum number of spectral lines $= \dfrac{(n_2 - n_1 + 1)(n_2 - n_1)}{2} = \dfrac{(5-1+1)(5-1)}{2} = 10$

9.(C) $\ell = 0, 1, 2, \ldots (n-1)$

$\therefore$ for $n = 3$

$\ell = 0, 1, 2 \quad \Rightarrow \quad \ell = 3$

Not possible for $n = 3$

10.(B) For 2s, there is one radial node and ψ^2 is max at r = 0.

11.(D) Number of total nodes = (n – 1).

12.(C) Fact base problem

Azimuthal quantum number '*l*'

For a given '*n*' can have values

As 'ℓ' = 0, 1, 2, ..., (n – 1)

Statement (E) is in correct for *l* = 5

No. of orbitals $= (2\ell + 1) = (2 \times 5 + 1) = 11$ orbitals.

13.(300) $\phi = \dfrac{hc}{\lambda}$

$$6.63 \times 10^{-19} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{\lambda} \quad \Rightarrow \quad \lambda = 3 \times 10^{-7}\,m = 300\,nm$$

14.(2) A – N = 3, ℓ = 0 to 2 – not possible for ℓ = 3

B – n = 3, ℓ = 0 to 2, m = –2 to +2 possible set

C – n = 2, ℓ = 0, 1m = +1 to –1 possible set

D – n = 2, ℓ = 0, 1 not possible for ℓ = 2

15.(22) $\Delta V = 2.4 \times 10^{-26}\,m/s$

$$\Delta x = 10^{-7}\,m \quad \Rightarrow \quad \Delta x \cdot m\Delta V = \frac{h}{4\pi} \quad \Rightarrow \quad 10^{-7} \times m \times 2.4 \times 10^{-26} = \frac{6.626 \times 10^{-34}}{4 \times 3.14}$$

$$\Rightarrow \quad m = 0.219 \times 10^{-1}\,kg \quad \Rightarrow \quad m \simeq 22\,g$$

16.(B) We know that $r = a_0 \times \dfrac{n^2}{Z}$

$$\therefore \quad r_3(H) = a_0 \times \frac{3^2}{1} \quad \Rightarrow \quad r_3(H) = 9\,a_0 \quad \Rightarrow \quad a_0 = \frac{r_3(H)}{9}$$

Now, $r_4(H) = a_0 \times \dfrac{4^2}{1} \quad \Rightarrow \quad r_4(H) = \dfrac{r_3(H)}{9} \times 16$

17.(A) Radial node = n – *l* – 1

Angular node = *l*

4d, n = 4, *l* = 2

Radial node = 4 – 2 – 1 = 1

Angular node = 2

18.(5) $\sigma = 0.35 \times 0 + 0.85 \times 2$ (Slater rule)

$= 1.7$

$Z_{eff} = Z - \sigma = 3 - 1.7 = 1.3$

$E_{Li} = -2.2 \times 10^{-18} \dfrac{(Z_{eff})^2}{(1)^2}, \ (Z_{eff})_{Li} = 1.3$

$E_{Li} = -3.718 \times 10^{-18}\,J$

So IE $= +3.718 \times 10^{-18}\,J = \dfrac{hc}{\lambda}$

So, $\lambda = \left(\dfrac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3.718 \times 10^{-18}}\right)$

$\lambda = 5.34 \times 10^{-8}\,m \quad \Rightarrow \quad \lambda \simeq 5 \times 10^{-8}\,m = x \times 10^{-8}\,m$; So x = 5 Ans

19.(D) Isoelectronic species $\Rightarrow$ same number of electrons

So Al^{3+} $\Rightarrow$ $10e^-$

O^{2-} and Mg^{2+} have $10\,e^-$

20.(B) **No. of unpaired e⁻**

V^{2+} : [Ar] $3d^3 4S^\circ$ = 3

Ni^{2+} : [Ar] $3d^8 4S^\circ$ = 2

Cr^{2+} : [Ar] $3d^4 4S^\circ$ = 4

Fe^{2+} : [Ar] $3d^6 4S^\circ$ = 4

$\Rightarrow$ Spin only magnetic moment $(\mu) = \sqrt{n(n+2)}$

Ni^{2+} has least no of unpaired electrons and hence it has lowest spin only magnetic moment.

21.(C) For minimum energy $E = E_0$

$E_0 = h\nu_0$ $\Rightarrow$ $E = 6.6\times10^{-34}\times1.3\times10^{15}\text{J}$ $\Rightarrow$ $E = 8.58\times10^{-19}\text{J}$

22.(B) Only (B) option has electron pair in degenerated orbitals as per "n+1" rule.

23.(C) Energy of one mole of photon $= \dfrac{hc}{\lambda}\times N_A$

$\lambda = 300\,\text{nm} = 300\times10^{-9}\text{m}$

$$E = \frac{hc}{\lambda}\times N_A$$

$$E = \frac{(6.63\times10^{-34})\text{Js}\times(3\times10^{8}\text{ms}^{-1})}{300\times10^{-9}\text{m}}\times N_A$$

E = 399258.6 J/mole

E = 399.2586 kJ/mole

E = 399 kJ/mol (By rounding off)

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Solutions of Archive - JEE Main & Advanced

Periodic Properties	Class - XI | Chemistry

JEE Main 2021

1.(A) Left to right in a periodic table ionization enthalpy increases (general trend)

$\underbrace{1E_1(Mg)}_{\substack{\text{fully filled} \\ \text{s-subshell}}} > 1E_1(Al)$

$\underbrace{1E_1(P)}_{\substack{\text{half filled} \\ \text{p-subshell}}} > 1E_1(S)$

2.(A) Across the period, I.E. of elements increases

Elements having half filled and fully filled configuration have higher I.E. in comparison to adjacent next element.

Hence, order of I.E.

$N > O > Be > B$

$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$

$2p^3 \; 2p^4 \; 2s^2 \; 2p^1$

3.(C) $33-[Ar]4s^2 3d^{10} 4p^3$ – As (Metalloid)

$53-[Kr]4d^{10} 5s^2 5p^5$ – I (Non Metal)

$83-[Xe]4f^{14} 5d^{10} 6s^2 6p^3$ (Bi – Metal)

4.(D) X - $I.E_1 = 495$ and $I.E_2 = 4000$

Large difference in I.E. values

Hence, after removal of 1st electron, highly stable configuration is achieved.

So $X \rightarrow$ Alkali Metal – Na

Y - $IE_1 = 700$ and $IE_2 = 1400$

As successive I.E. values always increases but the difference is NOT too large

Also $IE_1 = 700$, which is more than 495 due to stability of fully filled s orbital $Y \rightarrow Mg$

5.(B) As we go from left to right in a periodic table ionization energy increases.

$1E_1(Mg) < 1E_1(Ar)$

$1E_1(Mg) < 1E_1(Cl)$

$1E_1(Mg) > 1E_1(Na)$

6.(B) ΔH_{eg} order of halogens

F	Cl	Br	I
−332	−349	−324	−295

7.(B) Be – Al, B – Si and Li – Mg show diagonal relationship but Li – Na are not placed diagonally, they are elements of same group.

8.(C) Na > Mg > Al

$Na^+ > Mg^{2+} > Al^{3+}$ order of size

1.02 0.72 0.54

9.(C) In 3rd period of the periodic table order of 1st ionization energy is

Na < Al < Mg < Si < S < P < Cl < Ar

I.E. of Mg > Al and that of P > S due to extra stability of electronic configurations of these elements

10.(D) Among isoelectronic species i.e.,

Al^{3+}, Mg^{2+}, Na^+

Size $\propto \frac{1}{Z}$ where $Z \rightarrow$ nuclear charge

Therefore,

Order of ionic radii : $Na^+ > Mg^{2+} > Al^{3+}$

K^+ has the highest radius because of an extra shell

$\therefore$ Overall order : $Ag^{3+} < Mg^{2+} < Na^+ < K^+$

11.(C)

Element	**Value of Z**	**value of e¯s**	**z/e ratio**
F^-	9	10	0.9
O^{2-}	8	10	0.8
N^{3-}	7	10	0.7

Higher the z/e ratio, smaller is the size.

12.(B) In 1869, Mendeleev created Periodic Table

In 1898, JJ Thomson proposed structure of atom (NCERT).

13.(D)

		13th	14th	15th
2nd period	$2s^2 2p^1$	B	C	N
3rd period	$3s^2 3p^1$	Al	Si	P
4th period	$4s^2 4p^1$	Ga ↘	Ge	As
5th period	$5s^2 5p^1$	In	Sn	Sb

Element is $_{50}Sn = [kr]4d^{10}5s^2 5p^2$

14.(B) As we go from left to right in a period the metallic character decreases and non metallic character increases as ionization energy increases and electron gain enthalpy increases

Hence A is true and R is false.

15.(D) For isoelectronic species,

Ionic radii $\propto \frac{1}{\text{Atomic number}}$

$\therefore$ Order of ionic radii : $P^{3-} > S^{2-} > Cl^- > K^+ > Ca^{2+}$

JEE Main 2022

1.(80) $\Delta T_f = k_f m$

$$1560 - 155.1 = 2 \times \frac{1.80}{M} \times \frac{1000}{50} \quad \Rightarrow \quad M = 80 g/mol$$

2.(C) IE – Si > Mg > Al > Na

Na – 496 kJ / mole

Ma – 737 kJ / mole

Al – 577 kJ / mole

Si – 786 kJ / mole

3.(A) Metallic character usually decreases from left to right in a period and increases from top to bottom. Order of metallic character : Na > Mg > Be > Si > P.

4.(B) Ionization enthalpy order $\underbrace{B < A}_{\text{Full filled configuration Is more stable}} < \underbrace{D < C}_{\text{Half-filled configuration is more stable}}$

5.(D) The first ionization enthalpy of Ga is lower than that of Zn

Zn(30) = [Ar], $3d^{10}$, $4s^2$

Ga(31) = [Ar], $3d^{10}$, $4s^2$, $4p^1$

6.(B) The metal gallium (Ga) has a low melting point of 29.78°C. It is placed left to Germanium which is a metalloid in 4th period.

7.(D) Statement I is incorrect but Statement II is correct. (Radius of anionic species is always greater than their parent atomic radius).

8.(D) 1st I.E. $\underset{(2p^3)}{N} > \underset{(2p^4)}{O} > \underset{(2s^2)}{Be} > \underset{(2p^1)}{B}$

9.(D) Atomic number 103.

10.(A) First IE of O > First IE of N because four electrons in 2p-orbitals of oxygen experience more electron-electron repulsion.

11.(A) Electronic configuration of Pt is $[Xe]4f^{14}5d^9 6s^1$.

12.(A) Valence shell electronic configuration of E : $3d^{10}4s^2 4p^4$

For the element, just above E, valence shell electronic configuration : $3s^2 3p^4$

13.(A) All are isoelectronic species.
So, for isoelectronic species

Ionic radius $\propto \frac{1}{\text{atomic mass}}$

14.(D) O^{2-} and Mg^{2+} do not have same ionic radii but both are isoelectronic species (10 electrons in each).

15.(B) It is fact

16.(B) $Na_2O \rightarrow$ Basic

$As_2O_3 \rightarrow$ Amphoteric

$N_2O \rightarrow$ Neutral

$NO \rightarrow$ Neutral

$Cl_2O_7 \rightarrow$ Acidic

17.(B) Fact $\Rightarrow$ Ag have highest melting point.

Since Hg, Ga and Cs are liquid at or near room temperature.

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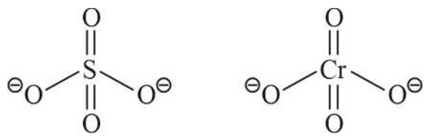
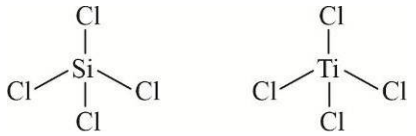
Chemical Bonding-I & II	Class - XI | Chemistry

JEE Main 2021

1.(B) **(A)**



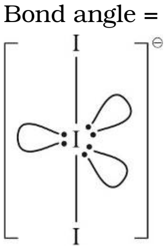
(B)



2.(D) I_3^- is sp^3d hybridized

Shape : Linear

Bond angle = 180°



3.(A) Calculate Bond order :

Be_2 = Total e^-s = 8

$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2$

$B.O = \frac{4-4}{2} = 0,$ Zero means molecule does not exist

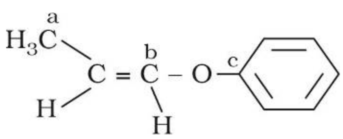
4.(B) In SF_4 two bonds are axial and two bonds the equatorial as the electronic geometry of SF_4 is trigonal bipyramidal and shape is see-saw shape. So the bonds are unequal.

5.(C) Assertion is false; Reason is true.

6.(D)

	BO
Ne_2	0
N_2	3
F_2	1
O_2	2

7.(D)



Hybridization of a = sp^3 (4 sigma bonds)

Hybridization of b = sp^2 (3 sigma +1 pi bonds)

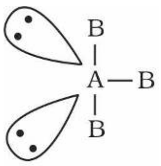
Hybridization of c = sp^2 (3 sigma +1 pi bonds)

8.(2) Number of lone pairs with central atom = (no. of valence electrons – number of electrons used in bond formation)/2

$SF_4 : \frac{6-4}{2} = 1$; $BF_4^- : \frac{3+1-4}{2} = 0$; $ClF_3 : \frac{7-3}{2} = 2$; $AsF_3 : \frac{5-3}{2} = 1$

$PCl_5 : \frac{5-5}{2} = 0$; $BrF_5 : \frac{7-5}{2} = 1$; $XeF_4 : \frac{8-4}{2} = 2$; $SF_6 : \frac{6-6}{2} = 0$

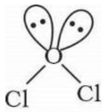
9.(A)



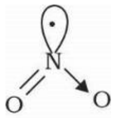
T-shaped

10.(15) Total number of electrons in AX must be 15 for bond order 2.5

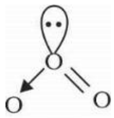
11.(D) Using VSEPR theory :

(A) $Cl_2O \Rightarrow$ 

Bent

(B) $NO_2 \Rightarrow$ 

Bent

(C) $O_3 \Rightarrow$ 

Bent

(D) $\overset{\ominus}{N} = \overset{\oplus}{N} = \overset{\ominus}{N}$

Linear

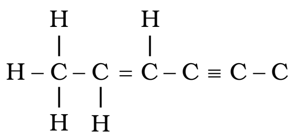
12.(0) B.O. of CO = 3

B.O. of $NO^{\oplus} = 3$

Δ B.O. $= (B.O.)_{CO} - (B.O)_{NO^{\oplus}} = 3 - 3 = 0 = x/2$ (given) $\Rightarrow$ $x = 0$

13.(10) $O_2^{2-} = \sigma 1s^2, \sigma^* 1s^2, \sigma 2S^2, \sigma^* 2S^2, \sigma 2P_z^2, \pi 2P_x^2 = \pi 2P_y^2, \pi^* 2P_x^2 = \pi^* 2P_y^2$

Total bonding $e^- = 10$

14.(10) 

15.(A) $O_2 = \sigma_{1s}^2 \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2 \pi_{2p_x}^2 = \pi_{2p_y}^2\ \pi_{2p_x}^{*1} = \pi_{2p_y}^{*1}$

$B.\ O = \frac{1}{2}(6-2) = 2$

$O_2^+ = \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2 \pi_{2p_x}^2 = \pi_{2p_y}^2 \pi_{2p_x}^{*1}$

$B \cdot O = \frac{1}{2}(6-1) = 2.5$

$O_2^- = \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 = \pi_{2p_y}^2 \pi_{2p_x}^{*2}\ \pi_{2p_y}^{*1}$

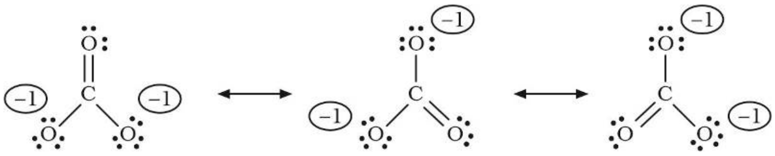
$B.O = \frac{1}{2}(6-3) = 1.5$

$O_2^{2-} = \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2 \pi_{2p_x}^2 = \pi_{2p_y}^2 \pi_{2p_x}^{*2} = \pi_{2p_y}^{*2}$

$B.O = \frac{1}{2}(6-4) = 1$

Decrease order of bond order $O_2^+ > O_2^- > O_2^- > O_2^{2-}$

16.(D)



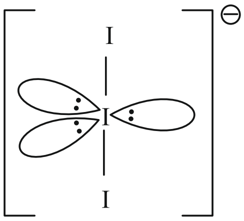
17.(D) $SF_4 = sp^3d$

$IF_5 = sp^3d^2$

$NO_2^+ = sp$

$NH_4^+ = sp^3$

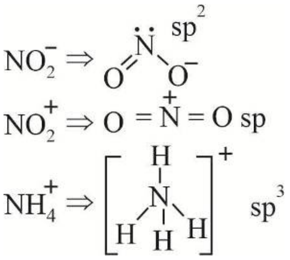
18.(3) Structure of $I_3^{\ominus}$



No of lone pairs on central atom is 3.

19.(B) NO_2^-, NO_2^+, NH_4^+

sp^2 sp sp^3



20.(A) CuI

1.73 BM, it means number of unpaired electron = 1

species	unpaired electron
O_2^-	1
O_2^+	1
Cu^+	0
Cu^{2+}	1

21.(173)

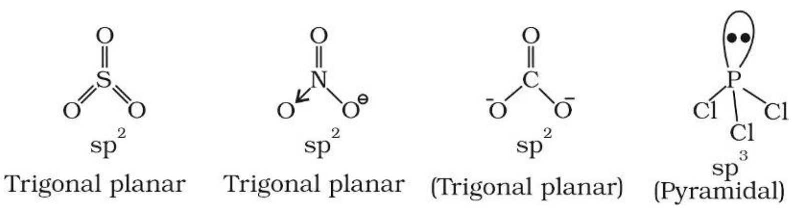
$B_2^+ \Rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^1$

$\therefore$ B_2^+ have 1 unpaired electron and its spin only magnetic moment is 1.73 Bm

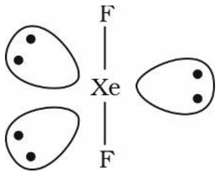
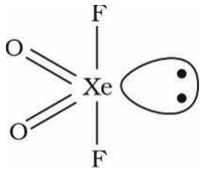
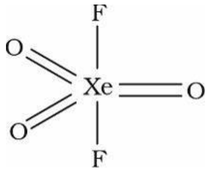
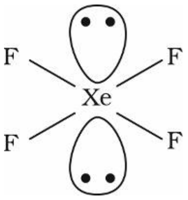
22.(0) Number of unpaired e^-s in $O_2^{2-} = 0$

$O_2^{2-} = KK^* \sigma_{2s}^2 \sigma_{2s}^{*2} \sigma_{2pz}^2 \pi_{2px}^2 \pi_{2py}^2 \pi_{2px}^{*2} \pi_{2py}^{*2}$

23.(C)



24.(A)

XeF_2		Lone pairs on central atom = 3
XeO_2F_2		Lone pairs on central atom = 1
XeO_3F_2		Lone pairs on central atom = 0
XeF_4		Lone pairs on central atom = 2

25.(A) The interaction energy of London forces between two particles is proportional to $\frac{1}{r^6}$ i.e. r^{-6}

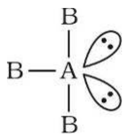
So, $x = -6$

26.(A) $O_2^- \to \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 = \pi_{2p_y}^2\ \pi_{2p_x}^{*2} = \pi_{2p_y}^{*1}$

1 unpaired electron is present, hence O_2^- is paramagnetic.

$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{10-7}{2} = 1.5$$

27.(2) T-shaped molecule means 3 sigma bond and 2 lone pairs of electron on central atom.



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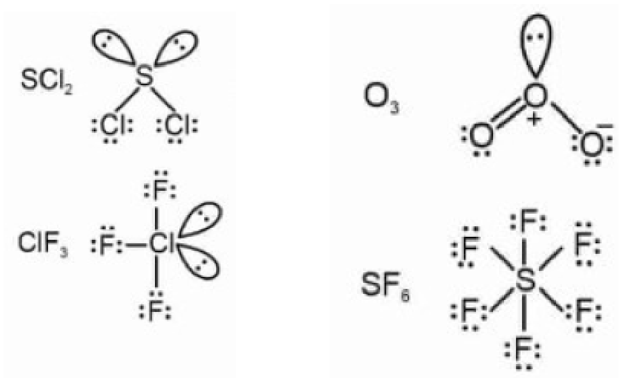
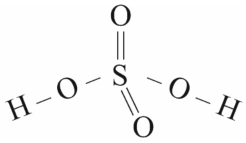
1.(B)



2.(B) Expanded octet: means more than 8 electron in outermost shell.

Sulphur has 12 electrons around it

$H_2SO_4 \longrightarrow$ 

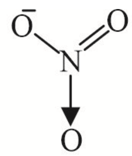
$\Rightarrow$ NO is an odd electron species with total $7+8=15$ electrons in it $\cdot\ddot{N}=O$.

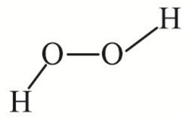
3.(A) Overlapping of orbitals is possible when the orbital wave functions intermix in "same phase". "Out of phase" overlap is zero overlap. It results due to unfavourable approach of the orbitals towards each other. Hence both (A) and (R) are true and (R) is correct explanation of (A).

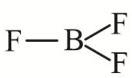
4.(3) Square pyramidal structures are BrF_5, IF_5 and ClF_5.

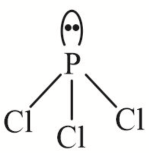
5.(4) Paramagnetic B_2, C_2^-, O_2^+ and He_2^+.

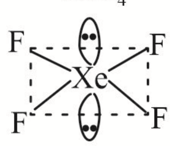
6.(6) NO_3^-

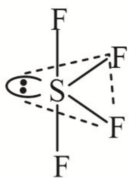
NO_3^-  Planar

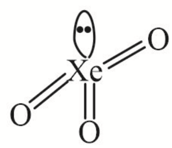
H_2O_2  Non-planar
open book like structure

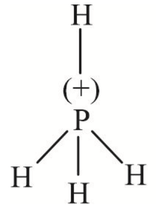
BF_3  Planar

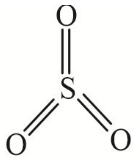
PCl_3  Non-planar

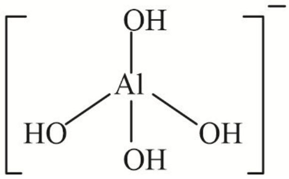
XeF_4  Planar

SF_4  Non-planar

XeO_3  Non-planar

PH_4^+  Non-planar

SO_3  Planar

$\left[Al(OH)_4\right]^-$ 

Non-planar

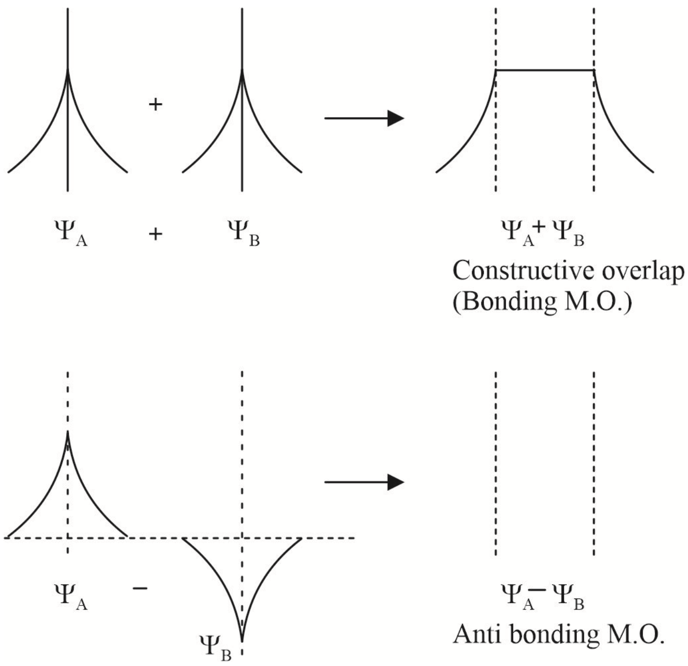
7.(A)

Li ↘ Be ↘ B

Na Mg Al

Diagonal relation

8.(C)



Dipole moment (M) = (separated charge) × (Inter nuclear distance)

$M = Q \cdot r$

$$\text{Bond Order} = \frac{\text{number of bonding } e^{-1} - \text{number of anitbonding } e^{-1}}{2}$$

9.(3) Bond Order

CN^-	→	3
NO^+	→	3
O_2	→	2
O_2^+	→	2.5
O_2^{2+}	→	3

10.(B) According to Fajan's rule, covalent character α size of anion.

Order of size of anion ⇒ $F^- < Cl^- < Br^- < I^-$

Order of covalent character ⇒ $CaF_2 < CaCl_2 < CaBr_2 < CaI_2$

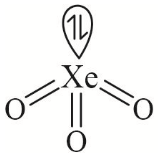
11.(C) $BrF_5 \rightarrow$ Square pyramidal

$[CrF_6]^{3-} \rightarrow$ Octahedral

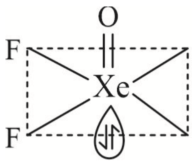
$O_3 \rightarrow$ Bent

$PCl_5 \rightarrow$ Trigonal Bipyramidal

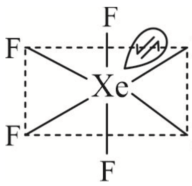
12.(3)



- one lone pair on central atom

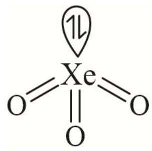


- one lone pair on central atom



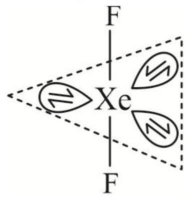
- one lone pair on central atom

13.(A) **I.**



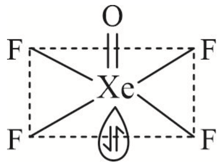
- sp^3 - pyramidal

II.



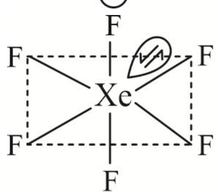
- sp^3d - linear

III.



- sp^3d^2 - square pyramidal

IV.



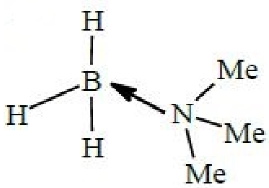
- sp^3d^2 - distorted octahedral

14.(1) $DU = 4 + 1 - \left(\frac{5-1}{2}\right) = 3$

$H_3C - CH = CH - C \equiv N$
$\uparrow$
sp^3

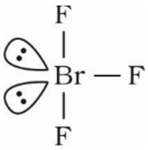
15.(2) Diamagnetic species are N_2, O_2^{2-}.

16.(B)



$BF_3 + NaH \xrightarrow{450K} \underset{\text{(diborane)}}{B_2H_6} + NaF$

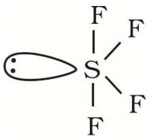
$B_2H_6 + NMe_3 \rightarrow 2 \underset{\text{symmetrical cleavage}}{[BH_3 \leftarrow NMe_3]}$

17.(C) 

Bent-T-shape, 2 lone pair on central atom.

18.(B) CH_4, NH_4^+ and BH_4^- are isoelectronic as well as isostructural. Hence all are tetrahedral.

19.(C) Covalent character increases with increase in polarization power.

20.(A) 

lone pair electron in SF_4 structure lies on equatorial position.

21.(1) Hybridization of P in PF_5 is sp^3d.

22.(C) Hydrogen bond is formed between $H^{\delta+}$ of hydrogen attached to electronegative element and $E^{\delta-}$ of electronegative element. Out of H_2O, NH_3, HCN and CH_4 order of decreasing intermolecular hydrogen bond is $H_2O > NH_3 > HCN > CH_4$.

23.(B) T-shaped $\rightarrow$ ClF_3

Trigonal planar $\rightarrow$ BF_3

Square planar $\rightarrow$ XeF_4

See-saw $\rightarrow$ SF_4

24.(A)

	B.O
O_2^{--}	1
O_2^-	1.5
O_2	2
O_2^+	2.5

25.(1)

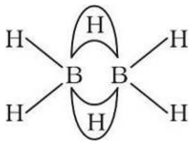
Molecules	**Number fo lone pairs**
SF_4	12 + 1 = 13
XeF_4	12 + 2 = 14
CF_4	12
H_2O	2

26.(C) In NO and O_2. Bond order increase by removal of an electron, so bond strength is increases.

$\therefore$	B.O. $\propto$ B.S.
NO	$\frac{\text{B.O.}}{2.5}$
NO^+	3.0
O_2	2.0 so answer is NO and O_2 (C)
O_2^+	2.5

27.(3) H_2O, NH_3 and HCl are 3 molecule with a non-zero net dipole moment.

28.(C) (A) (B)



There are two 3 centre - 2 - electron bonds

(C) B_2H_6 is electron deficient species

(E) B_2H_6 is non - Planar molecule

(D) $BF_3 + LiAlH_4 \rightarrow 2B_2H_6 + 3LiF + 3AlF_3$

$NaBH_4 + I_2 \rightarrow B_2H_6 + 2NaI + H_2$

29.(B) Bond order $= \frac{1}{2}$ [Bonding electron – Anti bonding electron]

$= \frac{1}{2}[N_b - N_a]$

Species	N_b	N_a	Bond order
C_2^{2-}	10	4	$\frac{1}{2}[10-4] = 3$
N_2^{2-}	10	6	$\frac{1}{2}[10-6] = 2$
O_2^{2-}	10	8	$\frac{1}{2}[10-8] = 1$
			$O_2^{2-} < N_2^{2-} < C_2^{2-}$

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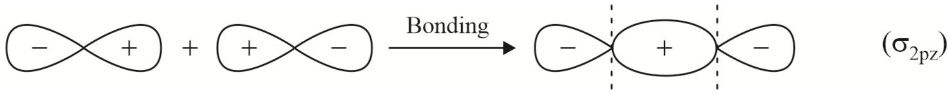
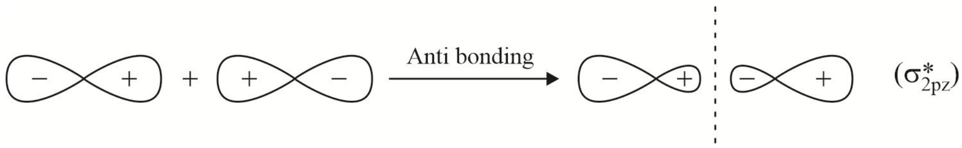
1.(D) Only (D) is correct

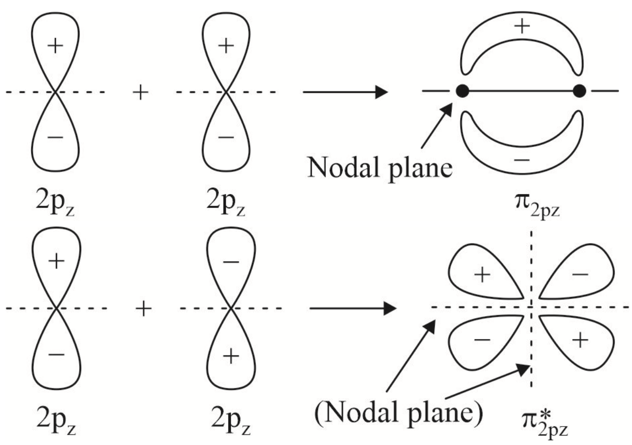


Nodal Plane = 2



Nodal plane = 1

$\Rightarrow$ O node in xz-plane $(\sigma^* 2p_z)$



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1.(8) $C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

If $C_xH_y = V_{ml}$

O_2 used $= \left(x+\frac{y}{4}\right)V$

CO_2 produced $= xV$

As per questions, $\left(x+\frac{y}{4}\right)V = 6V$ and $xV = 4V$

And $x = 4$ & $y = 8$

2.(5) $PV = nRT$

$$\left(\frac{740}{760}\right)\times V = \left(\frac{4.75}{26}\right)\times 0.0826\times 323 \quad \Rightarrow \quad V = 5L$$

3.(70) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$; $\frac{35}{300} = \frac{40}{T_2}$ $\Rightarrow$ $T_2 = \frac{40\times 300}{35} = 342.86\,k = 69.71°C = 70°C$

4.(1) $P(V_m - b) = RT$

$PV_m - Pb = RT$

$\frac{PV_m}{RT} - \frac{Pb}{RT} = 1$

$Z = 1 + \frac{Pb}{RT}$

$\left(\frac{\partial Z}{\partial P}\right)_T = \frac{b}{RT}$

5.(150)

From Dalton's law

$P_T = P_{CH_4} + P_{CO_2}$

$$P_T = \left(n_{CH_4} + n_{CO_2}\right)\frac{RT}{V} = \left(\frac{6.4}{16}+\frac{8.8}{44}\right)\times\frac{8.314\times 300}{10} = 149.65 \approx 150$$

6.(1) $\text{Mole} = \frac{20\times 10^{-3}}{0.083\times 273}$

Number of molecules $= \frac{20\times 10^{-3}}{0.083\times 273}\times 6.023\times 10^{23}$

Number of atoms $= \frac{20\times 10^{-3}}{0.083\times 273}\times 6.023\times 10^{23}\times 2 = 1.0632\times 10^{21}$

7.(875) $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

	$2SO_2(g)$	$O_2(g)$	$2SO_3(g)$
Start	250 m bar	750 m bar	0
Completion	0	$\left[750-\frac{250}{2}\right]$ m bar	250 m bar

$P_{Total} = 875\,m\,bar$

8.(927) $\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow \frac{300\times10^3\,Pa}{300} = \frac{1.2\times10^6\,Pa}{T_2} \Rightarrow T_2 = \frac{1.2\times10^6\times300}{300\times10^3} = 1200\,K = 927°C$

9.(A) Although, viscosity decreases on heating, but it is not the reason behind smoothing of glass on heating upto it melting point.

10.(19) $C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$

Mole $\frac{100}{44}$ $\frac{1000}{32}$

Limiting reagent will be C_3H_8

Hence, moles of CO_2 produced $\left(\frac{100}{44}\times3\right)$ moles ≈ 6.82 mole

$H_2O(\ell)$ produced $\left(\frac{100}{44}\times4\right)$ moles $= 9.09$ moles

Moles of O_2 left $= \left[\frac{1000}{32}-\frac{100}{44}\times5\right] = 19.89$ mole

$X_{CO_2} = \frac{x_{CO_2}}{x_{CO_2}+x_{O_2}+x_{H_2O}} = \frac{6.82}{6.82+19.89+9.09} = 0.19$; Ans. = 19

11.(2) $p = \frac{nRT}{V} = \frac{WRT}{M°(V)} \Rightarrow P_2 = P_1\left[\frac{w_2}{w_1}\right] = 3.47\left[\frac{23-14.8}{29-14.8}\right] = 3.47\left[\frac{8.2}{14.2}\right] = 2$

12.(C) For ideal gas
$PV = nRT$

At constant temperature
PV = constant

13.(D) $P = \frac{an^2}{V^2}$

$atm = \frac{a\,(mol)^2}{(dm^3)^2}$

Unit of $a = atm\,dm^6\,mol^{-2}$

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1.(25) $Z = 1 + \frac{Pb}{RT}$

$2 = 1 + \frac{99 \times b}{0.083 \times 298}$

$b = 0.2498 = 24.98 \times 10^{-2}$

2.(8) $PV = nRT$

$P = 6\,bar = 6 \times 10^5\,N/m^2$

$V = 0.0125 m^3$

$R = 8.3\,JK^{-1}\,mol^{-1}$

$T = 27 + 273 = 300K$

$n_{Total} = \frac{PV}{RT} \quad \Rightarrow \quad n_{Total} = \frac{6 \times 10^5 \times .0125}{8.3 \times 300} = 3$

$n_{Total} = 3 \quad \Rightarrow \quad n_{H_2} + n_{He} = 3 \quad \Rightarrow \quad \frac{W_{H_2}}{2} + \frac{W_{He}}{4} = 3$

$2W_{H_2} + W_{He} = 12$ .... (1)

(given) $W_{H_2} + W_{He} = 10$ .... (2)

on solving $W_{H_2} = 2\,gm$; $W_{He} = 8gm$

3.(2) $H_2 = 40\%$ (w/w)

$O_2 = 60\%$ (w/w)

Mass of hydrogen + oxygen = 100

$H_2 = 40$

H_2 mole $= \frac{40}{2} = 20$; O_2 mole $= \frac{60}{32} = 1.8$

Mole fraction of $H_2 = \frac{20}{20 + 1.8} = 0.9$

$P_{H_2} = P_T X_{H_2} = 2.2 \times 0.9 = 1.98 = 2$

4.(1655)

Moles of $C_3H_8 = \frac{11}{44} = 0.25\,moles$

$PV = nRT \quad \Rightarrow \quad 2 \times 10^6 \times 2 \times 10^{-3} = 0.25 \times 8.3 \times T \quad \Rightarrow \quad T = 1927.710\,K = 1654.56°C$

5.(152) $d = \frac{PM_o}{RT} \quad \Rightarrow \quad M_o = \frac{dRT}{P} = \frac{0.46 \times 0.082 \times 530}{(100/760)} = 151.93\,g/mol \approx 152\,g/mol$

6.(4) $pV = nRT$; $PV = \frac{w}{M_0}RT$

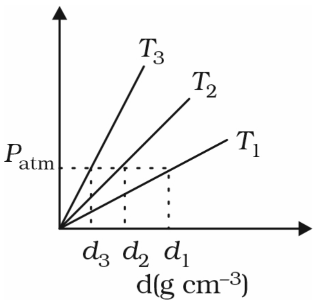
$M_0 = \frac{w \times RT}{V \times p} = \frac{100 \times 0.083 \times 300}{1.5 \times 416} = 3.99 \approx 4$

7.(B) $PV = nRT$ {Ideal gas equation}

$P = \frac{dRT}{M}$

$P \propto d$

So, graph must be straight line with zero intercept.



At constant pressure density is inversely proportional to absolute temperature. So, at d_1 density is largest. Hence temperature is lowest $T_3 > T_2 > T_1$.

8.(D) Volume of liquid = $\frac{\text{Mass of liquid}}{\text{Density of liquid}} = \frac{135-40}{0.95}\text{mL} = 100\,\text{mL}$

For gas

$V = \frac{nRT}{P} = \frac{WRT}{MP} = \frac{(40.5-40)\times 0.082\times 250}{M\times 0.82}\,L = \frac{0.5\times 0.082\times 250}{M\times 0.82}\times 1000\text{ mL}$

Vol. of container is same

Hence, $\frac{0.5\times 0.082\times 250}{M\times 0.82}\times 1000 = 100 \quad \Rightarrow \quad M = \frac{0.5\times 0.082\times 250\times 1000}{0.82\times 100} = 125$

9.(32) $PV = nRT$ (n, v constant)

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\frac{30\ atm}{300\,K} = \frac{P_2}{318\,K} \quad \Rightarrow \quad P_2 = 31.8\,K \simeq 32$

10.(45) Since both gases are ideal. Hence at same condition of temperature & pressure.

$n_A T_A = n_{H_2} T_{H_2}$ [from PV = nRT]

(A gas) (H_2 - gas)

$\frac{3g}{M_A}\times(300K) = \frac{0.2\,g}{2\,g/mol}(200K)$

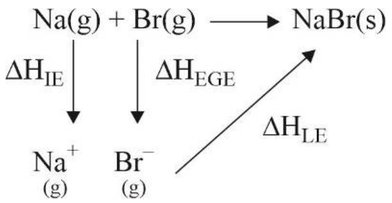
M_A (molar mass of A) $= 45\,g\,mol^{-1}$

Solutions of Archive - JEE Main & Advanced

Thermochemistry	Class - XI | Chemistry

JEE Main 2021

1.(5576)



$\Delta_f H°(NaBr) = \Delta_{IE}H(Na(g)) + \Delta_{EG}H(Br(g)) + \Delta_{LE}H$

$= 495.8 + (-325) + (-728.4) = -557.6 = -5576 \times 10^{-1}$ kJ mol^{-1} ; Answer = 5576

[In question, the energy of formation of NaBr(s) is asked, so the constituent elements should be considered in their standard state.So, $\Delta_{sub}HNa\,(s)$, $\Delta_{vap}HBr\,(\ell)$ and $\Delta_{BDE}HBr_2(g)$ should be given]

2.(741) $NH_2CN\,(s) + \frac{3}{2}O_2(g) \longrightarrow N_2(g) + CO_2(g) + H_2O\,(\ell)$

$\Delta_{ng} = (1+1) - \frac{3}{2} = \frac{1}{2}$

$\Delta H = \Delta U + \Delta_{ng}RT = -744.24 + \frac{1}{2} \times \frac{8.314 \times 298}{1000} = -742.24 + 1.24 = -741$ kJ / mole

3.(309) $S(g) + 6F(g) \longrightarrow SF_6$

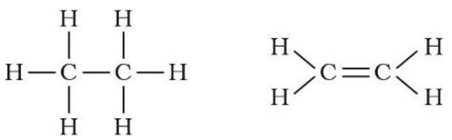
$\Delta H^\circ_R = (\Delta H^\circ_f)_{SF_6} - (\Delta H^\circ_f)_S - 6(\Delta H^\circ_f)_F = (-1100) - 275 - 6 \times 80 = -1855$ kJ

Now, $\Delta H^\circ_R = 0 - 6 \times (\Delta H^\circ_b)_{S-F} \quad \Rightarrow \quad (\Delta H^\circ_b)_{SF} = \frac{1855}{6} = 309.16$ kJ / mol

4.(230) $3CaO + 2Al \longrightarrow 3Ca + Al_2O_3$

$\Delta_r H° = \sum H^\circ_P - \sum H^\circ_R = \left[H^\circ_f Al_2O_3\right] - \left[3 \times H^\circ_f CaO\right] = -1675 - \left[3 \times (-635)\right] = -1675 + 1905 = 230$

5.(128) $C_2H_6 \longrightarrow C_2H_4 + H_2$



$\Delta_r H = B.E._{C-C} + 6B.E._{C-H} - (B.E._{C=H} + 4B.E._{C-H} + B.E._{H-H})$

$= 347 + 6(414) - (611 + 4(414) + 436) = 128$ kJ mol^{-1}

6.(82) Reaction involved

$H_2SO_4 \;+\; 2\,NaOH \longrightarrow Na_2SO_4 \;+\; 2\,H_2O$

80 mm 60 mm

$\therefore$ NaOH is the limiting reagent

Moles of OH^- reacted $= 60 \times 10^{-3}$ moles

Heat liberated by reaction of 1 mole of OH^- ions is 57.1 kJ.

$\therefore$ Heat liberated in the reaction $(Q) = 60 \times 10^{-3} \times 57.1 \times 10^3 \text{ J} = 60 \times 57.1 \text{ Joule}$

As $Q = ms(\Delta T)$

$$(\Delta T) = \frac{60 \times 57.1}{1000 \times 4.18} = 0.8196 = 81.96 \times 10^{-2} = 82$$

7.(101) $X(s) \rightleftharpoons X(\ell) \qquad \Delta H_1 = 2.8 \text{ KJ/mol}$

$X(\ell) \rightleftharpoons X(g) \qquad \Delta H_2 = 98.2 \text{ KJ/mol}$

$X(s) \rightleftharpoons X(g) \qquad (\Delta H_1 + \Delta H_2) = 101 \text{ kJ/mol}$

$\Rightarrow \Delta H$ sublimation

8.(26) Volume $= 4 \times 10^3 \text{dm}^3 = 4 \times 10^6 \text{ L}$

$P = 1 \text{atm} \qquad T = 300 \text{K}$

$PV = nRT$

$$n_{CH_4} = \frac{1 \times 4 \times 10^6}{0.083 \times 300}$$

$$\text{Mass of } CH_4 = \frac{4 \times 10^6}{0.083 \times 300} \times 16 = 25.6 \times 10^5 \text{gm}$$

9.(A) Heavier isotopes form stronger bonds $E_{H-H} < E_{D-D}$; $E_H \approx E_D - 7.5$

10.(21) $C + O_2 \longrightarrow CO_2 \qquad \Delta H = -2.48 \times 10^2 \text{ kJ/mole}$

$\underset{(12\,g)}{1 \text{ mole C}}$ heat $= 2.48 \times 10^2$ kJ

$$1 \text{ g C heat} = \frac{2.48 \times 10^2}{12} \text{kJ} = 21 \text{kJ}$$

11.(45) $\Delta H = -y = -45 \text{ kJ mol}^{-1}$

12.(964)

$FeO(s) + C(\text{graphite}) \longrightarrow Fe(s) + CO(g)$

$\Delta H^\circ_{reaction} = \Delta H_f(P) - \Delta H_f(R)$

$\Delta H^\circ_{reaction} = [0 + (-110.5)] - [-266.3]$

$\Delta H^\circ_{reaction} = 155.8 \text{ kJ/mol}$

$\Delta H^\circ_{reaction} = \Delta S_{product} - \Delta S_{reactant}$

$\Delta H^\circ_{reaction} = (27.28 + 197.6) - (57.49 + 5.74)$

$\Delta H^\circ_{reaction} = 161.65 \text{ J/mol-K}$

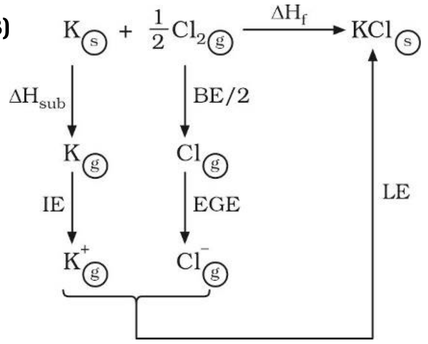
$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

For spontaneous reaction $\Delta G < 0$

$\therefore \qquad 0 = \Delta H^\circ - T_{min}\Delta S^\circ$

$$T_{min} = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{155.8 \times 10^3}{161.65} \approx 964 \text{ K (approx) (Integral Value)}$$

13.(718)



$$\Delta H_f = \Delta H_{sub} + IE + \frac{BE}{2} + EGE + LE$$

$$-436.7 = (+89.2) + (+419) + \left(\frac{243}{2}\right) + (-348.6) + LE$$

$LE = -717.8$ $\quad\quad |LE| = 718$

JEE Main 2022

1.(D) $C + O_2 \rightarrow CO_2 \quad \Delta H = -400$ ...(I)

$C + \frac{1}{2}O_2 \rightarrow CO \quad \Delta H = -150$ ...(II)

Mass of $C = 0.6 \times 100 \times \frac{60}{100} = 360\,gm$

60% of $360 = \frac{60}{100} \times 360 = 216\,gm$

From (II) $1\,mol\,C = 1\,mol\,CO = -10\,kJ$

$\frac{216}{12}\,mol\ C = \frac{216}{12} \times 100 = -1800\,kJ$

From (I) $1\,mol\ C = -400\,kJ$

$\frac{144}{12}\,mol = 12 \times 400 = -4800\,kJ$

Total Heat = $-(1800 + 4800) = -6600\,kJ$

2.(3) Internal energy (U), volume (V), Enthalpy (H) are state variables. Heat (q) is a path variable.

3.(57) $H_2F_2(g) \longrightarrow H_2(g) + F_2(g)$

$\Delta U = -59.6\,kJ/mol$

$T = 273 + 27 = 300\,K$

$\Delta H = \Delta U + \Delta ng\ RT$

$\Delta ng = (n_p - n_R)_g = 2 - 1 = 1$

$\Delta H = -(59.6) + \left(\frac{1 \times 8.314 \times 300}{1000}\right) = -59.6 + 2.49 = -57.11\,kJ/mol$

4.(200) $C(s) + O_2(g) \rightarrow CO_2(g)$

Mole of $C = \frac{2.4}{12} = 0.2$

Quantity of Heat released from reaction $= -C_v \times \Delta T = -20 \times 2 = -20 \times 2 = -40\,kJ$

For combustion of 1 mole of C

$\Rightarrow \quad -\frac{40}{0.2} = -200\ kJ/mole$

5.(2) $\Delta H_{ionisation}$ of $CH_3COOH = |-57.3 - (-55.3)| = 2\,kJ/mol$

6.(104) $3C(g) + 4H_2(g) \rightarrow C_3H_8(g) = -103.7\,kJ\,mol^{-1}$

7.(727) $\Delta n_g = 1 - \frac{3}{2} = -\frac{1}{2}$

$\Delta H = \Delta U + \Delta ng\ RT = -726 - \frac{1}{2} \times \frac{8.3}{1000} \times 300$

8.(300) $\Delta S = -550\,JK^{-1}$

$\Delta H = -165\ kJ/mol$

$\Delta G = \Delta H - T\Delta S$

At equilibrium, $\Delta G = 0$

$0 = -165 \times 100 - T(-550) \quad \therefore \quad T = 300\,K$

9.(747) $2O_3 \rightleftharpoons 3O_2(g)$

$\frac{2}{5} \qquad \frac{3}{5}$

$k_p = \frac{P_{O_2}^3}{P_{O_3}^2} \Rightarrow k_p = 1.35$

$\Delta G° = -RT\ln k_p = -8.3 \times 300 \times \ln 1.35 = -747\ J/mol$

10.(C) Combustion of ethane $\rightarrow$

$C_2H_6(g) + \frac{7}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$

$\Delta_C H(C_2H_6) = 2\Delta_f H(CO_2)(g) + 3\Delta_f H(H_2O) - \Delta_f H(C_2H_6)$

$-1560 = 2(-394) + 3(-286) - \Delta_f H(C_2H_6)$

$\Delta_f H(C_2H_6) = -86.0\ kJ/mol$

JEE Advanced 2022

1.(90.39)

$q_{reaction} = C \times \Delta T = 20(312.8 - 298) = 20 \times 14.8$

For 2 moles, $|\Delta U| \times 2 = 20 \times 14.8$

$\Rightarrow \quad |\Delta U| = 148\ kJ/mole \quad \Rightarrow \quad \Delta U = q_V = -148\ kJ/mole$

$Hg(g) + \frac{1}{2}O_2(g) \longrightarrow HgO(s), \quad \Delta U = -148\ kJ/mole$

$\Delta H = \Delta U + \Delta n_g RT$

$\Rightarrow \quad \Delta H = -148 - \frac{3}{2}RT = -148 - \frac{3}{2} \times 8.3 \times 10^{-3} \times 298 = -151.7101$

$\therefore \quad \Delta H°_{reaction} = \Delta_f H°_{(HgO)} - \frac{1}{2}\Delta_f H°_{(O_2)} - \Delta_f H°_{(Hg)}$

$\Rightarrow \quad -151.7101 = x - 0 - 61.32$

$\Rightarrow \quad x = -151.7101 + 61.32 = -90.39\ kJ/mole \quad \Rightarrow \quad |x| = 90.39$

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Solutions of Archive - JEE Main & Advanced

Thermodynamics	Class - XI | Chemistry

JEE Main 2021

1.(15) For isothermal process $\Delta U = 0$, $\Delta Q = -\Delta W$

$$V_i = \frac{nRT}{P_i} = \frac{5 \times 8.314 \times 293}{2.1 \times 10^6} = 5800 \times 10^{-6} m^3$$

$$V_f = \frac{nRT}{P_f} = \frac{5 \times 8.314 \times 293}{2.1 \times 10^6} = 9369.23 \times 10^{-6} m^3$$

$$\Delta W = -P_{ext}(V_f - V_i)$$

$$\Delta W = -4.3 \times 10^6 (9369.23 - 5800) \times 10^{-6}$$

$$= -4.3(3569.23) = -15347 \text{ J / mol} = -15.347 \text{ kJ / mol}$$

So the heat transferred is 15 kJ / mol

2.(855) $3HC \equiv CH \rightleftharpoons C_6H_6$

$$\Delta G^\circ = \Delta G^\circ_{C_6H_6} - 3\Delta G^\circ_{HC \equiv CH} = -1.24 \times 10^5 - (3 \times -2.04 \times 10^5) = 4.88 \times 10^5$$

$$\Delta G^\circ = -2.303 RT \log K$$

$$4.88 \times 10^5 = -2.303 \times 8.314 \times 298 \log K$$

$$\log K = -855 \times 10^{-1}$$

$$|\log K| = 855 \times 10^{-1}$$

3.(1380)

$$\Delta G^\circ = -RT \ln K_{eq} = -R(300)\ln 100 = -1380 R$$

4.(200) $A + B \rightleftharpoons C + D$

$$\Delta H^\circ = 80 \text{ kJ / mol}$$

$$\Delta S^\circ = 2T$$

At equilibrium, $\Delta G = 0$

$$\Delta H - T\Delta S = 0$$

$$80000 - T \times 2T = 0$$

$$2T^2 = 80000 \quad \Rightarrow \quad T^2 = 40000 \quad \Rightarrow \quad T = 200 K$$

Temperature above which reaction becomes spontaneous $= 200 K$

5.(2218)

$$Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$$

$$n_{H_2} = n_{Fe} = \frac{50}{55.85}$$

$$w = -P\Delta V = -\Delta n_{(g)}RT = -\frac{50}{55.85} \times 8.314 \times 298 J = -2218 J$$

$$|w| = 2218 J$$

6.(166) $\Rightarrow \quad \Delta G° = -RT\ln K_p \quad \Rightarrow \quad \Delta G° = -8.3\times 400\times \ln K_p$

$\Rightarrow \quad \Delta G° = -8.3\times 400\times 2.3\times \log_{10} K_p \quad \Rightarrow \quad 25.2\times 10^3 = -8.3\times 400\times 2.3\times \log_{10} K_p$

$\Rightarrow \quad -3.3 = \log_{10} K_p \quad \Rightarrow \quad K_p = 10^{-3.3} \quad \Rightarrow \quad K_p = \frac{10^{-3}}{2}$

Also, $K_p = K_C(RT)^{\Delta ng}$

Given reaction : $2A(g) \rightleftharpoons A_2(g)$

$\Delta n_g = (1-2) = (-1) \quad \therefore \quad K_p = K_C(RT)^{-1}$

$\frac{10^{-3}}{2} = K_C(8.3\times 400)^{-1} \quad \Rightarrow \quad K_C = \frac{10^{-3}\times 8.3\times 400}{2} \quad \Rightarrow \quad K_C = 166\times 10^{-2} \quad \therefore \quad$ Ans = 166

7.(D) **(A)** water $\xrightleftharpoons{0°C}$ ice ; $\Delta S = -ve$ **(B)** water $\xrightleftharpoons{-10°C}$ ice; $\Delta S = -ve$

(C) $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g); \quad \Delta S = -ve$

(D) Adsorption, so $\Delta S = -ve$

(E) $NaCl(s) \longrightarrow Na^+(aq) + Cl^{\ominus}(aq); \Delta S = +ve$

8.(31) $\Delta_{vap}H - \Delta_{vap}U = \Delta_{ng}RT = 1\times 8.31\times 373 = 3101 = 31\times 10^2$

9.(50) $\Delta U = q + W = 150 + (-200) = -50\,J$

10.(667)

Heat of combustion of glucose, $\Delta_C H = -2700\,kJ/mol$

$C_6H_{12}O_6 + 9O_2 \longrightarrow 6CO_2 + 6H_2O$

For one mole of glucose, energy released is 2700 kJ

For 10000 kJ, moles of glucose require $= \frac{10000}{2700}$

Amount of glucose = moles × molar mass

$\Rightarrow \quad \frac{10000}{2700}\times 180 = 666.67 = 667g$ after rounding off.

11.(360)

$\Delta G = -49.4\,kJ/mol \qquad \Delta H = 51.4\,kJ/mol$

$\Delta G = \Delta H - T\Delta S \qquad T = 300K$

$-49.4 = 51.4 - 300\Delta S$

$\Delta S = \frac{51.4 + 49.4}{300} = 0.336\,kJ/K = 336\,J/K$

12.(5) $\Delta G = \Delta H - T\Delta S = -57.8 + \frac{298[176]}{1000} = -57.80 + 52.45 = 5.35$

13.(C) **(A)** $W_{\text{isothermal reversible}} = -nRT\ln\frac{V_f}{V_i}$

(B) $-T = \frac{\Delta G_{system}}{\Delta S_{total}}$

(C) $\Delta G° = -RT\ln k$

$\Delta H° - T\Delta S^0 = -RT\ln k$

So given equation is incorrect

(D) $k = e^{-\frac{\Delta G°}{RT}}$

14.(84) After long time; let say final pressure is P atm and final temperature be TK.

$\therefore$ Heat lost by container I = Heat receive by container II

$$n_1C_m(300-T) = n_2C_m(T-60)$$

$$\left(\frac{2.8}{28}\right)(300-T) = \frac{0.2}{28}(T-60)$$

$$4200-14T = T-60 \Rightarrow 15T = 4260 \Rightarrow T = 284K$$

Total volume = 3L

Final temperature = 284 K

Total moles $= \left(\frac{3}{28}\right)$

$$\text{Pressure} = \frac{3}{28}\times\frac{8.31\times 284}{3\times 10^{-3}}\text{Pa} = 84287\,\text{Pa} = 0.84287\,\text{bar} = 84.287\times 10^{-2}\,\text{bar}$$

15.(82)

	HCl	+	NaOH	$\longrightarrow$	NaCl	+	H_2O
Millimoles	40		30				
	10		–		30		

Molar heat of neutralization is $57.1\,kJ$

$$\Delta H = 57.1\times 30\times 10^{-3}\times 10^{3}\,J$$

$$\Delta H = 1713\,J$$

Since, $\Delta H = mC\Delta T$

Total mass of water = 500

$$1713 = 500\times 4.18\Delta T$$

$$\Delta T = \frac{1713}{500\times 4.18} \Rightarrow \Delta T = 0.82 \Rightarrow \Delta T = 82\times 10^{-2}\,°C$$

16.(38) $H_2O(\ell) \longrightarrow H_2O(g)$

$$\Delta H_{vap} = 41\,kJ/mol$$

$$q = \Delta H_{vap} = 41\,kJ/mol$$

$$W = -P\Delta V = P(V_{H_2O(g)} - V_{H_2O(\ell)})$$

Volume of $H_2O(\ell)$ is negligible in comparison to $H_2O(g)$

$$W = -PV_{H_2O(g)} \Rightarrow W = -nRT \Rightarrow W = -1\times 8.3\times 373\,J$$

$$W = -\frac{1\times 8.3\times 373}{1000}\,kJ \Rightarrow W = -3.095 \Rightarrow W \approx -3\,kJ$$

$$\Delta U = q + W = 41 - 3 \Rightarrow \Delta U = 38\ kJ/mol$$

JEE Advanced 2021

1.(166.28)

$$X(s) \rightleftharpoons Y(s) + Z(g) \qquad K = \frac{P_z}{P^{\Theta}}$$

$$\Delta G° = \Delta H° - T\Delta S°$$

$$-RT\ln k = \Delta H° - T\Delta S°$$

$$\ln k = \frac{\Delta S°}{R} - \frac{\Delta H°}{RT}; \qquad \ln\frac{P_x}{P^{\Theta}} = \frac{\Delta S°}{R} - \frac{\Delta H°}{RT}$$

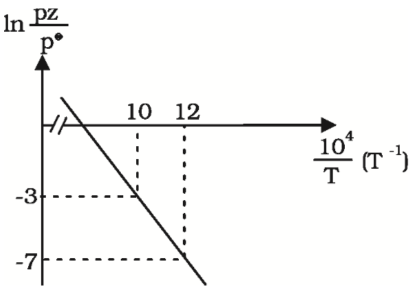
Slope of $\frac{\ln P_z}{P°}$ vs $\frac{1}{T} = \frac{-\Delta H°}{R}$

From graph, $\frac{-\Delta H°}{R} = -2\times 10^4$; $\quad \Delta H° = 2\times 10^4\times 8.314 = 166.28\,kJ/mol$

2.(141.34)

$\Delta G° = \Delta H° - T\Delta S°$;

$-RT \ln k = \Delta H° - T\Delta S°$



$\ln k = -\frac{\Delta H°}{RT} + \frac{\Delta S°}{R}$

From graph, $y = mx + c$

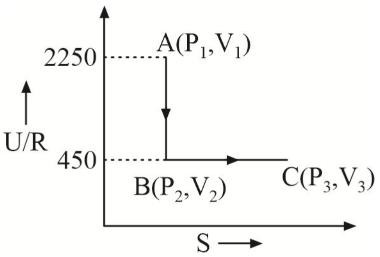
$-7 = 12m + c$; $-3 = 10m + c$

$m = 2$; $c = 17$

$\frac{\Delta S°}{R} = 17$

$\Delta S° = 17 \times 8.314 = 141.338 \text{ JK}^{-1}$

3.(10)



For AB process, q = 0

$\Delta U = W$

$\Rightarrow$ $W = 450R - 2250R = -1800R$

$T_B = T_C$ $\Rightarrow$ $450 = \frac{5}{2} \times T_B$ (T_B = Temperature at point B)

$T_B = 180K = T_C$

$W_{II} = W_{BC} = nRT \ln \frac{V_3}{V_2} = 1 \times R \times 180 \ln \frac{V_3}{V_2}$

$1800R = 180R \ln \frac{V_3}{V_2}$; $\ln \frac{V_3}{V_2} = 10$

4.(ABD)

(A) Slope : Isothermal < Adiabatic

$I \rightarrow II$ (Isothermal)

$II \rightarrow III$ (Adiabatic)

(C) Incorrect

$II \rightarrow III$ Adiabatic expansion

In adiabatic expansion, temp dec.

$\Delta H = nC_p dT$

$\Delta H = -ve$

(D) Correct

$I \rightarrow II$ Isothermal expansion T is constant

$II \rightarrow III$ Adiabatic expansion, temp decreases, $\Delta S = 0$

JEE Main 2022

1.(54) $600\,\text{ml of } 0.2\,\text{m } + HNO_3 + 400\,\text{ml of } 0.1\,\text{m NaOH}$

To calculate rise in the temperature of the flask _______ $\times 10^{-2}$°C

HNO_3 + NaOH

600×0.2 400×0.1

120 m moles 40 m moles

So reactive no. of m moles $= 40 = 40 \times 10^{-3}$ moles

As given $\Delta H_{neutralisation} = 57 \times 10^3$ J mole

So, heat $= 40 \times 10^{-3} \times 57 \times 10^3 = 2280$ J mole

Now use MCDT = q

$2280 = 4.2 \times \Delta T \times 1000 \quad \Rightarrow \quad 54 \times 10^{-2°C} \quad \Rightarrow \quad \Delta T = 0.54$

2.(A) $H = U + PV$

$\Delta H = \Delta U + \Delta(PV)$

$\Delta H = \Delta U + P\Delta V + V\Delta P$

$\Delta H = \Delta U + P\Delta V$ (For constant P)

$\Delta H = \Delta U + V\Delta P$ (For constant V)

3.(35) $q = \text{Heat capacity} \times \Delta T = 2.5 \times 0.45 = 1.125\,\text{kJ}$

9 kJ heat is produced by combustion of 1 mol

$\therefore$ 1.125 kJ produced by combustion $= \frac{280}{9} \times 1.125 = 35\,\text{g}$

4.(2) $du = nC_v dT$

$5000 = n(C_p - R)200$

$25 = n \times 12.471 \quad \Rightarrow \quad n = \frac{25}{12.471} \approx 2$

5.(195) $\Delta U = w + q$

$q = nC\Delta T = \frac{2.2}{44} \times 100 \times [270 - 310]$

$q = -200\,\text{J}$

$w = -P_{ext}[V_2 - V_1] = -1[167.75 - 217.1] \times \frac{1}{1000} = 0.04935 \text{ L atm} = 4.99\,\text{J}$

$\Delta U = -200 + 4.99 = -195\,\text{J} = -x\text{J}$

6.(117) $NH_3(\ell) \longrightarrow NH_3(g); \quad \Delta H = 23.4\,\text{kJ / mol}$

$\frac{17}{17} = 1\,\text{mole}$

$\frac{85}{17} = 5\,\text{mole} \qquad \Delta H = 117\,\text{kJ for } 85\,\text{gm } NH_3$

7.(600) $Mg(s) + \frac{1}{2}O_2(g) \longrightarrow MgO(s)$

$\Delta H = \Delta U + \Delta ngRT$

$-601.70 = \Delta U + \left(-\frac{1}{2} \times 8.3 \times 10^{-3} \times 300\right)$

$\Delta U = -601.70 - (-1.245) = -601.70 + 1.245 = -600.455 = -600\,\text{kJ / mole}$

8.(0) For an isothermal process

$\Delta T = 0$

$\Delta U = 0$

For expansion against vacuum,

$w = 0$

$\Delta U = q + w \quad \Rightarrow \quad q = 0$

9.(8630)

Work done in isothermal reversible expansion is

$$W.D. = 2.303\, nRT \log \frac{V_2}{V_1} = -2.303 \times 5 \times 8.3 \times 300 \log \frac{20}{10} = 8630\,J$$

10.(B) Spontaneous process $\Delta G < 0$

Process with $\Delta P = 0, \Delta T = 0 -$ isobaric and isothermal

$\Delta H_{reaction} = (B.E)_{reactants} - (B.E)_{products}$

Exothermic process $-$ $\Delta H < 0$

11.(2735)

$$\begin{array}{cccc} HI & \rightleftharpoons & 1/2H_2 & + & 1/2I_2 \\ 1 & & 0 & & 0 \\ (1-\alpha) & & \alpha/2 & & \alpha/2 \end{array} \quad \left(\text{Total moles } 1 - \alpha + \frac{\alpha}{2} + \frac{\alpha}{2} = 1\right)$$

Partial pressure $\frac{(1-\alpha)}{1} P_T \qquad \frac{\alpha}{2} P_T \qquad \frac{\alpha}{2} P_T$

$$K_P = \frac{[P_{H_2}]^{1/2} \cdot [P_{I_2}]^{1/2}}{P_{HI}} = \frac{\left[\frac{\alpha}{2}\right]^{1/2} \left[\frac{\alpha}{2}\right]^{1/2} \cdot P_T}{[1-\alpha] \cdot P_T}$$

$$K_P = \frac{\alpha}{2(1-\alpha)} = \frac{0.4}{2(1-0.4)} \quad \Rightarrow \quad K_P = \frac{0.2}{0.6} = \frac{1}{3} = 0.333$$

$$\Delta G = -8.31 \times 300 \ln 0.333 = 8.31 \times 300 \times 2.3 \times 0.477 = 2735\,J/mol$$

12.(38) $\Delta H = \Delta U + \Delta n_g RT$

$$41.1 = \Delta U + 1 \times \frac{8.31}{1000} \times 373 \quad \Rightarrow \quad 41.1 - 3.099 = \Delta U$$

This is only answer as it is asked per mole = 38 kJ/mole

13.(C) $3C_2H_2(g) \longrightarrow C_6H_6(\ell)$

$\Delta H = \Sigma(\Delta_C H)_{Reactant} - \Sigma(\Delta_C H)_{Product}$

$\Delta H = [3(-1300)] - [-3268] = -3900 + 3280\,kJ\ mol^{-1} = -632\,kJ\,mol^{-1}$

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Solutions of Archive - JEE Main & Advanced

Chemical Equilibrium	Class - XI | Chemistry

JEE Main 2021

1.(5) $Cl_2 \rightleftharpoons 2Cl$

$t = 0 \quad P_0 \quad -$

$t = t_{eq} \quad P_0 - P \quad 2P$

$= \frac{2P_0}{3} \quad = \frac{2P_0}{3}$

$P_0 - P = 2P \Rightarrow P_0 = 3P \Rightarrow P_0 - P = 2P$

$(P_T)_{eq} = 1 \Rightarrow \frac{4P_0}{3} = 1 \Rightarrow P_0 = \frac{3}{4}$

$$K_P = \frac{\left(\frac{2P_0}{3}\right)^2}{\left(\frac{2P_0}{3}\right)} = \frac{2}{3}P_0 = \frac{2}{3} \times \frac{3}{4} = 0.5 \Rightarrow K_P = 5 \times 10^{-1}$$

2.(20) $A(g) \rightleftharpoons B(g)$

$t = 0 \quad 22 \times 10^{-3} \quad 0$

$t = t \quad 22 \times 10^{-3} - x \quad x$

$$K_{eq} = \frac{x}{(22 \times 10^{-3} - x)}$$

$\Delta G^\circ = -9478 = -2.303 \times 495 \times \log K_{eq}$

$$\log K_{eq} = \frac{9478}{495 \times 2.303 \times 8.314} \Rightarrow \log K_{eq} = 1 \Rightarrow K_{eq} = 10$$

$$10 = \frac{x}{22 \times 10^{-3} - x} \Rightarrow 22 \times 10^{-2} = 11x$$

$x = 2 \times 10^{-2} = 20 \times 10^{-3}$ moles

Number of milimoles of B will be 20

3.(354) $K_P = K_C(RT)^{\Delta n_g}$

$600.1 = 20.4 \times (0.0831 \times T)^1$

$T = 354\,K$

4.(1400) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

$t = 0 \quad 3 \quad - \quad -$

$t = t_4 \quad 3 - x \quad x \quad x$

$$\Rightarrow \frac{x^2}{3 - x} = 1.844 \Rightarrow x = 1.6$$

Moles of PCl_5 at equilibrium $\Rightarrow 3 - x = 1.4$

5.(16) $K_p = PO_2^{1/2} = 4 \Rightarrow PO_2 = 16$ atm

6.(25)

$$A + B \rightleftharpoons 2C \quad K_{eq} = 100$$

$t = 0$ 1 1 1

$(1-x)$ $(1-x)$ $(1-2x)$

$$k_{eq} = \frac{[C]^2}{[A][B]} = \frac{(1+2x)^2}{(1-x)^2} = 100$$

$$\frac{1+2x}{1-x} = 10 \Rightarrow x = \frac{3}{4}$$

$$[C] = 1 + 2x = 1 + 2\left(\frac{3}{4}\right) = 2.5\,M$$

7.(2) $N_2O_4 \rightleftharpoons 2NO_2$

$$K_P = K_C(RT)^1$$

$$47.9 = K_C \times 0.0821 \times 288 \Rightarrow K_C = 2$$

8.(0 or 172)

$$k_p = \frac{(P_{SO_3})^2}{(P_{SO_2})^2(P_{O2})} = \frac{(43000)^2}{(45000)^2 \times 530} = 0.17 \times 10^{-2}$$

$$k_p = \frac{(P_{SO_3})^2}{(P_{SO_2})^2(P_{O2})} = \frac{(43)^2}{(45)^2 \times \left(\frac{530}{1000}\right)} = 172 \times 10^{-2}$$

9.(6)

	$NH_4HS(s)$ $\rightleftharpoons$	$NH_3(g)$ +	$H_2(g)$
$t = 0$	0.1 mol		$\alpha = 20\%$
$t = t$	$0.1(1-\alpha)$	$0.1(\alpha)$	$0.1(\alpha)$
Moles of time t	$0.1(0.8)$	$(0.1)(0.2)$	$(0.1)(0.2)$

$$P = \frac{nRT}{v} \Rightarrow \frac{(0.02)(0.082)(300)}{2} = 0.246$$

$$K_p = (P_{NH_3})(P_{H_2S}) = (0.246)^2 = 0.060 \Rightarrow 6.0 \times 10^{-2}$$

10.(182)

$$A + B \rightleftharpoons C + D, \quad K_C = 100$$

1 1 1 1

$$Q_C = \frac{1 \times 1}{1 \times 1} = 1$$

$Q_C = K_C \Rightarrow$ Reaction will proceed towards forward direction

$$A + B \rightleftharpoons C + D, \quad K_C = 100$$

1 1 1 1

$1-x$ $1-x$ $1-x$ $1-x$

$$100 = \frac{(1+x)^2}{(1-x)^2}$$

$$10 = \frac{1+x}{1-x} \Rightarrow x = \frac{9}{11}$$

$$[D] = 1 + x = 1 + \frac{9}{11} = \frac{20}{11} = 1.82 = 182 \times 10^{-2}$$

11.(0) At equilibrium $\frac{-d\left[[PtCl_4]^{2-}\right]}{dt} = 0$

$\Rightarrow \quad 4.8\times10^{-5}\left[[PtCl_4]^{2-}\right] - 2.4\times10^{-3}\left[[Pt(H_2O)Cl_3]^{-}\right][Cl^{-}] = 0$

$\Rightarrow \quad K_C = \frac{\left[[Pt(H_2O)Cl_3]^{-}\right][Cl^{-}]}{\left[[PtCl_4]^{2-}\right]} = \frac{4.8\times10^{-5}}{2.4\times10^{-3}} = 2\times10^{-2} \quad \Rightarrow \quad K_C = 0.02$

$\Rightarrow$ Nearest Integer $= 0$

JEE Main 2022

1.(2) $2NO + O_2 \rightleftharpoons 2NO_2$

	$2NO$	O_2	$2NO_2$
Initially	2	1	0
Finally	1.2	0.6	0.8

$$K_p = \frac{(P_{NO_2})^2}{(P_{NO})^2 P_{O_2}} = \frac{\left(\frac{0.8}{2.6}\times 1\right)^2}{\left(\frac{1.2}{2.6}\times 1\right)^2\left(\frac{0.6}{2.6}\times 1\right)} = \frac{(0.8)^2(2.6)}{(1.2)^2(0.6)} = 1.925$$

2.(2) $K = \frac{1}{\sqrt{20\times 10^{14}}} = \frac{1}{10^7\times(20)^{1/2}} = \frac{1}{10^7\times 4.47} = 0.22\times 10^{-7} = 2.2\times 10^{-8}$

3.(A) $n_T = \frac{PV}{RT} = \frac{6\times 100}{0.082\times 610} = 11.99 = 12 = 9 + x \Rightarrow x = 12 - 9 = 3$

$$K_P = \frac{P_{PCl_3}\times P_{Cl_2}}{P_{PCl_5}} = \frac{3}{12}\times 6\times\frac{3\times 6}{12}\times\frac{12}{2\times 6} \Rightarrow K_P = 2.25$$

4.(125) $2NOCl \longrightarrow 2NO + Cl_2$

	$2NOCl$	$2NO$	Cl_2
Initial moles	2	–	–
At equilibrium	$2 - x$	x	$\frac{x}{2}$

Given that : $x = 0.4 = [NO]$

$[NOCl] = 2 - x = 1.6$; $[Cl_2] = \frac{x}{2} = 0.2$

$$K_c = \frac{[NO]^2[Cl_2]}{[NOCl]}$$

$$K_c = \frac{(0.4)^2\times(0.2)}{(1.6)^2} = 0.0125 \Rightarrow K_c = 125\times 10^{-4}$$

5.(710) $N_2O_4 \rightleftharpoons 2NO_2$

	N_2O_4	$2NO_2$
$t = 0$	1 mol	
$t = t$	(1–0.5) mol = 0.5 mol	0.5×2 mol = 1 mol

$$k_p = \frac{\left(\frac{1}{1.5}\times 1\right)^2}{\left(\frac{0.5}{1.5}\times 1\right)} = \frac{1}{0.75} = \frac{100}{75} = 1.33$$

$$\Delta G^\circ = -RT\,ln\,k_p = -8.31\times 300\times \ln(1.33) = -710.45\text{ J / mol} = -710\text{ J / mol}$$

6.(B) $A(g) \rightleftharpoons B(g) + \frac{1}{2}C(g)$

	$A(g)$	$B(g)$	$\frac{1}{2}C(g)$
Initial	P_i	0	0
At eq.	$P_i(1-\alpha)$	$P_i\alpha$	$P_i\frac{\alpha}{2}$

Now, equilibrium pressure (P),

$$P = P_i\times\left(1+\frac{\alpha}{2}\right)$$

$\therefore \quad P_A = \left(\dfrac{1-\alpha}{1+\dfrac{\alpha}{2}}\right)P; \qquad P_B = \left(\dfrac{\alpha}{1+\dfrac{\alpha}{2}}\right)P; \qquad P_C = \left(\dfrac{\dfrac{\alpha}{2}}{1+\dfrac{\alpha}{2}}\right)P$

$\therefore \quad K = \dfrac{P_C^{1/2} \times P_B}{P_A} \quad \Rightarrow \quad K = \dfrac{\alpha^{3/2} P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$

7.(1107) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

	PCl_5	PCl_3	Cl_2
$t = 0$	5	0	0
$t = t_{eq}$	$5 - x$	x	x

From ideal gas equation $PV = nRT$

$2.46 \times 200 = (5 - x + x + x + 2) \times 0.082 \times 600 \quad \Rightarrow \quad x = 3$

Total moles $= 5 + x + 2 = 10$ moles

Partial pressure of PCl_5

$P_{PCl_5} =$ mole fraction $\times P_T = \dfrac{2}{10} \times 2.46$

Similarly : $P_{PCl_3} = \dfrac{3}{10} \times 2.46$

$PCl_2 = \dfrac{3}{10} \times 2.46$

$K_P = \dfrac{P_{PCl_3} \times PCl_2}{P_{PCl_5}} = \dfrac{3 \times 3}{2} \times \dfrac{2.46}{10} \quad \Rightarrow \quad K_P = 1.107 = 1107 \times 10^{-3}$

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Ionic Equilibrium	Class - XI | Chemistry

JEE Main 2021

1.(141) $Pb(NO_3)_2 \rightleftharpoons Pb^{2+} + 2NO_3^-$

$\quad\quad 0.1 \quad\quad 0.2$

$PbI_2 \rightleftharpoons Pb^{2+} + 2I^-$

$\quad s \quad\quad 2s$

$s + 0.1$

$K_{sp} = (S+0.1)(2S)^2 = 8\times10^{-9}$

$0.1(4S^2) = 8\times10^{-9} \quad \Rightarrow \quad S^2 = 2\times10^{-8} \quad \Rightarrow \quad S = 1.41\times10^{-4} = 141\times10^{-6}$

2.(D) $AgCN \rightleftharpoons Ag^+ + CN^-, \quad K_{sp} = 2.2\times10^{-16}$

$\quad x \quad\quad x$

$HCN \rightleftharpoons H^+ + CN^-, \quad K_a = 6.2\times10^{-10}$

$H^+ + CN^- \rightleftharpoons HCN, \quad K = \frac{1}{K_a} = \frac{1}{6.2\times10^{-10}}$

$K_{sp}\times K = [Ag^+][CN^-]\times\frac{[HCN]}{[H^+][CN^-]}$

$2.2\times10^{-16}\times\frac{1}{6.2\times10^{-10}} = \frac{x\times x}{10^{-3}}$

$x^2 = \frac{2.2}{6.2}\times10^{-9}\ ; \quad x = 1.9\times10^{-5}$

3.(D) $Ca(OH)_2 \rightleftharpoons Ca^{2+}(aq) + 2\ddot{O}H(aq)$

$\quad s \quad\quad 2s$

$K_{sp} = [Ca^{2+}][\ddot{O}H]^2 = (s)(2s)^2 = 4s^3 = 5.5\times10^{-6}$

$s^3 = \frac{5.5}{4}\times10^{-6}\ ; s^3 = 1.375\times10^{-6}\ ; \quad s = 1.11\times10^{-2}\,M$

4.(7) $(NH_4)_3PO_4$

$pK_a(H_3PO_4) = 5.23$

$pK_b(NH_4OH) = 4.75$

$pH = 7+\frac{1}{2}(pK_a - pK_b) = 7+\frac{1}{2}(5.23-4.75) = 7+\frac{1}{2}(0.24) = 7.24 \approx 7$

5.(1) H_2SO_3 is a weak dibasic acid

$[H^+] = \sqrt{K_{a_1}C} = \sqrt{1.7\times0.588\times10^{-2}} = 0.1$

$pH = -\log[H^+] = 1$

6.(64) $CdSO_4 \rightleftharpoons Cd^{2+} + SO_4^{2-}$

$K_{sp} = S^2$

$K_{sp} = (8 \times 10^{-4})^2 \qquad (\because S = 8 \times 10^{-4})$

$K_{sp} = 64 \times 10^{-8}$

0.01 M H_2SO_4 will form $\Rightarrow$ 0.02 M H^+ and 0.01 M SO_4^{2-} ions

$$\underset{}{BaSO_4(s)} \rightleftharpoons \underset{x}{Ba^{2+}(aq)} + \underset{x+0.01}{SO_4^{2-}}$$

$K_{sp} = x(x+0.01)$

$64 \times 10^{-8} = x(0.01) \qquad$ [Assume $0.01 + x \approx 0.01$]

$$x = \frac{64 \times 10^{-8}}{0.01} \Rightarrow x = 64 \times 10^{-6}\,M$$

7.(2) $$\underset{0.01(1-\alpha)}{HA} + H_2O \rightleftharpoons \underset{0.01\alpha}{H_3O^+} + \underset{0.01\alpha}{A^-}$$

$$HCl \longrightarrow \underset{0.1}{H_3O^+} + \underset{0.1}{Cl^-}$$

$$K_a = \frac{[H_3O^+]\cdot[A^-]}{[HA]} = \frac{(0.01\alpha + 0.1)(0.01\alpha)}{0.01(1-\alpha)}$$

As per common ion effect, dissociation of weak acid is suppressed so,

$$K_a = 0.1\alpha \Rightarrow \alpha = \frac{K_a}{0.1} = \frac{2 \times 10^{-6}}{0.1} = 2 \times 10^{-5}$$

8.(50) $$A_2X \rightleftharpoons \underset{2S_1}{2A^+} + \underset{S_1}{X^{2-}}$$

$4S_1^3 = 4 \times 10^{-12} \Rightarrow S_1 = 10^{-4}\,M$

$$MX \rightleftharpoons \underset{S_2}{M^+} + \underset{S_2}{X^-}$$

$S_2^2 = 4 \times 10^{-12} \Rightarrow S_2 = 2 \times 10^{-6}\,M$

$$\frac{S(A_2X)}{S(MX)} = \frac{100 \times 10^{-6}}{2 \times 10^{-6}} = 50$$

9.(10) $$pH = pK_a + \log\frac{[CH_3COONa]}{[CH_3COOH]}$$

$$5.74 = 4.74 + \log\frac{[CH_3COONa]}{1}$$

$1 = \log[CH_3COONa]$

$[CH_3COONa] = 10\,M$

10.(1) $$\underset{(0.005)}{Ba(OH)_2} \longrightarrow Ba^{2+} + \underset{\substack{(0.005 \times 2)\\ = 0.01\,\text{mole}}}{2OH^-}$$

$$\therefore \quad [OH^-] = 10^{-2}\,M \Rightarrow [H^+] = \frac{10^{-14}}{10^{-2}} = 10^{-12} = 1 \times 10^{-12}\ \text{mole / lit.}$$

11.(C) $AgCl \longrightarrow Ag^+ + Cl^-$

$\quad\quad S \quad S+0.1 \approx 0.1$

$K_{sp} = [S][S+0.1] \quad \Rightarrow \quad K_{sp} = [S][0.1] \quad \Rightarrow \quad [S] = \frac{K_{sp}}{0.1}$

$[S]_{Ag^+} = \frac{1.7\times10^{-10}}{0.1} = 1.7\times10^{-9}M$

$Ag_2CrO_4 \longrightarrow 2Ag^+ + CrO_4^{2-}$

$\quad\quad S \quad (S+0.001) \approx 0.001$

$K_{sp} = [2S]^{2-}[0.001] \quad \Rightarrow \quad 4S^2 = K_{sp}/0.01$

$S^2 = \frac{1.9\times10^{-12}}{0.001\times4} \quad \Rightarrow \quad S^2 = 0.48\times10^{-9} \quad \Rightarrow \quad S^2 = 4.8\times10^{-10} \quad \Rightarrow \quad S = 0.69\times10^{-5}$

Hence, Ag^+ needed in low amount to precipitate AgCl

12.(2) $K_{sp} = [Zn^{2+}][OH^-]^2 = S[0.1]^2 = 2\times10^{-20} \quad \Rightarrow \quad S = 2\times10^{-18}M \quad \therefore \quad x = 2$

13.(6021)

$MV = 50 - 30 = 20$

$M_{acid} = \frac{20}{80} = 0.25$

$pH = -\log[H_3O^+] = -\log(2.5\times10^{-1})$

$pH = 0.6021 = 6021\times10^{-4}$

14.(108)

$A_3B_2 \longrightarrow 3A + 2B$

$\quad\quad 3x \quad 2x$

$K_{sp} = (3x)^3(2x)^2$

$K_{sp} = 108x^5$ (x is in units of molarity)

$a = 108$

15.(4) $AgNO_3 + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+ \quad K_f = 1\times10^8$

Initial moles of $AgNO_3 = 2\times0.8 = 1.6$ moles

$AgNO_3 + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+ \quad K_f = 1\times10^8$

$1.6 \quad x \quad -$

$5\times10^{-8} \quad x = 2\times1.6 \quad 1.6$

$K_f = \frac{1.6}{5\times10^{-8}[NH_3]^2} \quad \Rightarrow \quad 1\times10^8 = \frac{1.6}{5\times10^{-8}[NH_3]^2}$

$[NH_3]^2 = \frac{1.6}{5\times10^{-8}\times10^8} \quad \Rightarrow \quad [NH_3] = 0.8 \quad \Rightarrow \quad x - 3.2 = 0.8 \quad x = 4$ (Nearest integer)

16.(3) So, $K_b = \frac{[NH_4^+][HO^-]}{[NH_3]}$

$[HO^-] = \frac{K_b\times[NH_3]}{[NH_4^+]} = 1.8\times10^{-5}\times\frac{2}{5}\times\frac{210}{504} = 3\times10^{-6}$

17.(C) Phenol phthalein $\Rightarrow$ Used for titration of weak acid with strong base

Methyl orange $\Rightarrow$ Used for titration of weak base with strong acid

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1.(C) Phenolphthalein is a weak organic acid, which get ionized in basic medium.

2.(B) $[H^+] = (200 \times 0.01 \times 1) + (400 \times 0.01 \times 2)$

$2 \quad + \quad 8 = 10$

$[H^+] = \frac{10}{600} = \frac{1}{60} \quad \Rightarrow \quad pH = -\log\left(\frac{1}{60}\right) = 1.78$

3.(282) $PbS \rightarrow Pb^{2+} + S^{2-}$

$1-5 \quad s \quad s$

$K_{sp} = S^2$

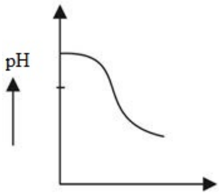
$S = \sqrt{Ksp} \quad \Rightarrow \quad S = \sqrt{8 \times 10^{-28}} = 10^{-14}\sqrt{4 \times 2} = 2 \times 10^{-14} \times 1.41 = 282$

4.(27) K_a of Butyric acid $\Rightarrow \quad 2 \times 10^{-5}\ pKa = 4.7$

pH of 0.2 M solution

$pH = \frac{1}{2}pK_a - \frac{1}{2}\log C = \frac{1}{2}(4.7)\frac{1}{2}\log(0.2) = 2.35 + 0.35 = 2.7 \quad \Rightarrow \quad pH = 27 \times 10^{-1}$

5.(A) Initially pH is of weak base is more than 7, on adding acid pH of solution will not drop sharply from basic range (above 7) to acidic range (below 7).



6.(0) $CaF_2 \rightarrow Ca^{2+} + 2F^-$

$S \quad (2S)$

$S = 2.34 \times 10^{-3}$ g/100 mL

$S = 2.34$ g/L

$S = 3 \times 10^{-4}$ mol / L

$S = 4(3 \times 10^{-4})^3 = 4 \times 2.7 \times 10^{-11} = 1.08 \times 10^{-10} = 0.0109 \times 10^{-8}$

7.(C) $HPh(ar) \rightleftharpoons H^+ + Ph^-$

(colourless) (pink)

(acidic medium) (basic medium)

8.(D) $H_2C_2O_4 \rightleftharpoons H^+ + HC_2O_4^- \qquad K_{a_1}$

$HC_2O_4^- \rightleftharpoons H^+ + C_2O_4^{2-} \qquad K_{a_2}$

$H_2C_2O_4 \rightleftharpoons 2H^+ + C_2O_4^{2-} \qquad K_{a_2} = K_{a_1} \times K_{a_2}$

9.(C) $NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$

2 m mole   2 m mole   –

–   –   2 m mole

$[NH_4^+] = \frac{2\text{ mmole}}{60\text{ ml}} = \frac{1}{30}M \quad \Rightarrow \quad pH = \frac{pK_w - pK_b - \log C}{2} = \frac{14 - 5 + 1.48}{2} = 5.24$

10.(D) Presence of common ion decreases solubility.

11.(B) $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

$$pH = pK_a + \log \frac{[CH_3 - CH_2 - COO^-]}{[CH_3 - CH_2 - COOH]}$$

$$pK_a = pH - \log \frac{[CH_3 - CH_2 - COO^-]}{[CH_3 - CH_2 - COOH]}$$

$$4.89 = 4 - \log \frac{[CH_3 - CH_2 - COO^-]}{[CH_3 - CH_2 - COOH]}$$

$$-0.89 = \log \frac{[CH_3 - CH_2 - COO^-]}{[CH_3 - CH_2 - COOH]}$$

$$\frac{[CH_3 - CH_2 - COO^-]}{[CH_3CH_2 - COOH]} = \text{Antilog} - 0.89 = 0.128 \approx 0.13$$

12.(11) 0.001 M NaOH solution

$[OH^-] = 0.001$ (Strong base)

$[OH^-] = 1 \times 10^{-3}$

$pOH = -\log 1 \times 10^{-3} = 3$

$pH + pOH = 14$

$pH = 14 - 3 = 11$

13.(476)

$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

Left in sol$^-$N 25 × 0.1

(50 – 25) × 0.1 = 2.5 m mol=2.5 m mol

Sol$^-$N Contains CH_3COOH and CH_3COONa. Hence it is buffer solution.

$$pH = pK_a + 10g \frac{2.5}{2.5} = pK_a = 4.76 = 476 \times 10^{-2}$$

14.(D) According to lewis acid base concept

15.(A)

	$Bi_2S_3(s)$ + aq	$\rightleftharpoons$	$2Bi^{+++}(aq)$ +	$3S^{--}(aq)$
t = 0	1		0	0
t = eq	1 – S		2S	3S

$K_{sp} = (2S)^2(3S)^3 \Rightarrow K_{sp} = 108S^5 = 108S^5 = 1.08 \times 10^{-73} \Rightarrow S = 1 \times 10^{-15}M$

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3.(10.02) $H_2CO_3 + NaOH \longrightarrow NaHCO_3$

	H_2CO_3	$NaOH$	$NaHCO_3$
$\rightarrow$	0.01	0.01	0.01
$\rightarrow$	0	0	0.01 + 0.01 = 0.02 mole

After the reaction,

$NaHCO_3 = 0.02\,\text{mole}$

$Na_2CO_3 = 0.01\,\text{mole}$

So, it is an acidic buffer solution $(HCO_3^- + CO_3^{2-})$

$$pH = pK_{a_2} + \log\frac{[CO_3^{2-}]}{[HCO_3^-]} = 10.32 + \log\frac{0.01}{0.02} = 10.32 + \log\left(\frac{1}{2}\right)$$

$$= 10.32 + \log 2^{-1} = 10.32 - \log 2 = 10.32 - 0.3 = 10.02$$

Solutions of Archive - JEE Main & Advanced

Stoichiometry-II (Redox Reactions)	Class - XI | Chemistry

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1.(D) $2I^- \longrightarrow I_2 + 2e^-$ (Oxidation Reaction)

$H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O$ (Reduction Reaction)

$$\underset{\text{R.A.}}{2I^-} + \underset{\text{O.A.}}{H_2O_2} + 2H^+ \longrightarrow I_2 + 2H_2O$$

2.(A) In 1st reaction oxidation state of 'Cl' is changing from +1 to −1 while that of 'O' in H_2O_2 is changing from −1 to 0. Hence H_2O_2 is acting as reducing agent.

In 2nd reaction oxidation state of 'I' is changing from 0 to −1 while that of 'O' in H_2O_2 is changing from −1 to 0. Hence H_2O_2 is acting as reducing agent.

3.(173) $N_1V_1 = N_2V_2$

$M_1 \times V_1 \times n = M_2 \times V_2 \times n$

$0.154 \times 3 \times V_1 = 0.25 \times 8 \times 40$

$V_1 = 173.16 \approx 173\,\text{mL}$

4.(D) In basic medium oxidizing action of H_2O_2

$Mn^{2+} + H_2O_2 \longrightarrow Mn^{4+} + 2OH^-$

In basic medium reducing action of H_2O_2

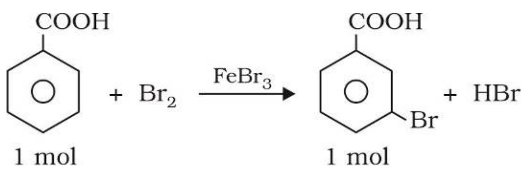
$I_2 + H_2O_2 + 2OH^- \longrightarrow 2I^- + 2H_2O + O_2$

In acidic medium oxidizing action of H_2O_2

$PbS(s) + 4H_2O_2(aq) \longrightarrow PbSO_4(s) + 4H_2O(\ell)$

5.(78) Mass of benzoic acid = 6.1 gm $\therefore$ Moles of benzoic acid $= \frac{6.1}{122}$

According to the reaction



$\therefore$ Moles of m-bromobenzoic acid $= \frac{6.1}{122}$

Mass of m-bromobenzoic acid $= \frac{6.1}{122} \times 201 = 10.05\,g$

% yield $= \frac{7.8}{10.05} \times 100 = 77.6\% \approx 78$

6.(50) Volume of Na_2CO_3 solution $= 10\,mL$

Molarity of HCl solution $= 0.2$

Volume of HCl solution $= 5\,mL$ (most accurate among all readings)

$(meq)_{HCl} = (meq)_{Na_2CO_3}$

$0.2 \times 1 \times 5 = M \times 2 \times 10$

$M = \dfrac{0.2 \times 1 \times 5}{2 \times 10} = 0.05$

$1M = 1000\,mM \quad \therefore \quad 0.05\,M = 0.05 \times 1000\,mM = 50\,mM$

7.(24) $(N_1V_1)Fe^{2+} = (N_2V_2)Cr_2O_7^{2-}$

$N_1 \times 15 = 0.03 \times 6 \times 20$

$N_1 = \dfrac{0.03 \times 6 \times 20}{15} = 0.24 = 24 \times 10^{-2}$

8.(B) Retardation factor (R_f) is unit less and its value depends on solvent parameters

9.(16) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

10.(1575)

Using law of chemical equivalence

Milli equivalents of $KMnO_4$ = Milli equivalents of oxalic acid

$10 \times 0.05 \times 5 = 10 \times M \times 2$

$\therefore$ Molarity of oxalic acid $= \dfrac{0.25}{2} = 0.125$ molar

Strength of solution = Molarity × Molar mass

$= 0.125 \times 126 = 1575 \times 10^{-2}$

11.(18) $Fe^{2+} + K_2\overset{+6}{Cr_2}O_7 \xrightarrow[H_2SO_4]{dil.} Fe^{3+} + 2Cr^{3+}$

Equation of Fe^{2+} oxidized = Equivalent of $K_2Cr_2O_7$ reduced

$(x \times 10^{2-}) \times 10 \times 1 = 15 \times 0.02 \times 6 \quad \Rightarrow \quad x = 18$

12.(B) **(a)** O.N. of Cr in $CrO_3 : +6$ **(b)** O.N. of Fe in $Fe_2O_3 : +3$

(c) O.N. of Mn in $MnO_2 : +4$ **(d)** O.N. of V in $V_2O_5 : +5$

(e) O.N. of Cu in $Cu_2O : +1$

13.(D) $MnO_4^- \longrightarrow Mn^{2+}$

In MnO_4^-, the oxidation state of Mn $= +7$

Change in oxidation state = 5

14.(D) BrO_4^-

$x + 4(-2) = -1 \quad \Rightarrow \quad x = +7$

Since Br is present in maximum oxidation state.

Hence it can only reduce, does not show disproportionation reaction.

15.(316)

$MnO_4^- \quad + \quad Fe^{2+} \quad \longrightarrow \quad Mn^{2+} \quad + \quad Fe^{3+}$

$nf = 5 \qquad nf = 1$

Milli equivalent of MnO_4^- = Milli equivalent of $FeSO_4$

$(\text{Molarity} \times \text{Volume} \times \text{n-factor})_{MnO_4^-} = (\text{Molarity} \times \text{Volume} \times \text{n-factor})_{FeSO_4}$

$5 \times M \times 10 = 1 \times 0.1 \times 10$

$\text{Molarity} = 0.02 \text{ mol / L}$

$\text{Strength} = \text{Molarity} \times \text{Molar mass of } KMnO_4$

$= 0.02 \times 158 = 3.16 \text{ g / L} = 316 \times 10^{-2} \text{ g / L}$

JEE Advanced 2021

Solution Stem for Question Nos. 1 and 2

1.(1.88) **2.(18.75)**

$KMnO_4 + Fe^{2+} \xrightarrow{H^+} Mn^{2+} + Fe^{3+}$

$250 \text{ ml solution} \longrightarrow \frac{x}{100} \text{ mol } Fe^{2+}$

$25 \text{ ml solution} \longrightarrow \frac{x}{1000} \text{ mol } Fe^{2+}$

$(eq)_{KMnO_4} = (eq)_{Fe^{2+}}$

$0.03 \times 5 \times \frac{12.5}{1000} = \frac{x}{1000} \times 1$

$x = 1.875 \simeq 1.88$

$\% \text{ Iron by weight} = \frac{1.875 \times 10^{-2} \times 56}{5.6} \times 100 = 18.75\%$

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1.(4) $MnO_4^{2-} \xrightarrow{H^+} MnO_4^- + MnO_2$

Number of unpaired $\bar{e} = 3$

$\therefore \quad \mu\sqrt{15} = 3.877$; Nearest Integer = 4

2.(4) $KMnO_4 + H_2O_2 \xrightarrow{OH^-} MnO_2 + O_2$

In basic medium, $KMnO_4$ is reduced to MnO_2.

Oxidation state of Mn in MnO_2 is +4.

3.(D) $S_2O_3^{2} + MnO_4^- \xrightarrow[\text{or neutral}]{\text{alkaline}} SO_4^{2-}$

4.(1) $\overset{+3}{C_2}H_2O_4 \rightarrow \overset{+4}{CO_2}$

Change in oxidation number = 1

5.(24) $\underset{nf=6}{K_2\overset{+6}{Cr_2}O_7} + \underset{nf=1}{Fe^{2+}} \longrightarrow Fe^{3+} + Cr^{+3}$

$\frac{20}{1000} \times 0.02 \times 6 = \frac{10}{1000} \times M \times 1$

0.24 M; i.e. 24

6.(4) Meq of Cu^{++} = Meq of Hypo

$\underset{(Meq)}{\text{milliequivalent}} = M \times V_{ml} \times n.f.$

$\underset{+2}{Cu^{++}} \longrightarrow \underset{+2.5}{Cu^+}$; n.f. for $Cu^{++} = 1$

$\underset{(Hypo)}{S_2O_3^{--}} \longrightarrow S_2O_5^{--}$

n. f. for Hypo $= (2.5 - 2) \times 2 = 1$

meq of $Cu^{++} = M \times 10 \times 1$

meq of Hypo $= 0.02 \times 20 \times 1$

$M \times 10 \times 1 = 0.02 \times 20 \times 1 \quad \Rightarrow \quad M = 0.04 = 4 \times 10^{-2}$

7.(D) The balanced reaction of H_2O_2 and acidified $KMnO_4$ is

$KMnO_4 + 5H_2O_2 + 3H_2SO_4 \longrightarrow 5O_2 + 2MnSO_4 + 8H_2O + K_2SO_4$

$KMnO_4$ is oxidizing agent, it oxidizes H_2O_2 to O_2 and itself reduces to Mn^{2+}.

8.(C) $MnO_4^- + 4H^+ + 3e^{(-)} \longrightarrow MnO_2 + 2H_2O$

Here Mn is in their highest oxidation state.

9.(A) $H_2O_2 + MnO_4^- \rightarrow Mn^{2+} + O_2$(unbalanced)

10.(30) meq of mohr's salt = meq of $KMnO_4^-$ used

$20 \times 0.05 = 0.05 \times Vml$

$V_{ml} = \frac{20 \times 0.05}{0.05} = 20\,ml$

Volume of $KMnO_4$ in burette = 50 – 20 = 30 ml.

11.(13) Number of meq. of MnO_2 = Number of meq. of Cl_2 = Number of meq. of hypo solution.

$2e^- + Mn^{4+} \rightarrow Mn^{2+}$

Valency factor of $MnO_2 = 2$

For Hypo solution, valency factor is 1

$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$

$z = \frac{2}{2} = 1$

Number of meq. of $MnO_2 = 60 \times 0.1 \times 1 = 6$

Mass of $MnO_2 = \frac{6}{1000} \times \text{Eq.wt.} = \frac{6}{1000} \times \frac{87}{2} = 0.261\text{g}$

$\% MnO_2 = \frac{0.261}{2} \times 100 = 13.05\%$

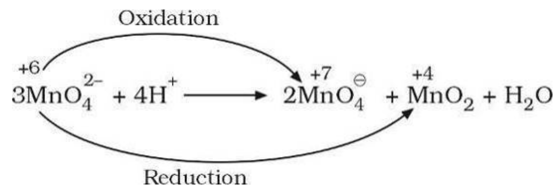
12.(85) Let the compound has x% of Fe^{2+} and $(0.93 - x)\%$ of Fe^{3+}

$2x + (0.93 - x)3 - 2 = 0 \quad \Rightarrow \quad x = 0.79$

$\%$ of $Fe^{2+} = \frac{0.79}{0.93} \times 100 \simeq 85\%$

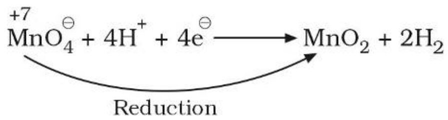
13.(C) Dihedral angle in H_2O_2 in solid is 90.2°.

14.(A) **(A)**

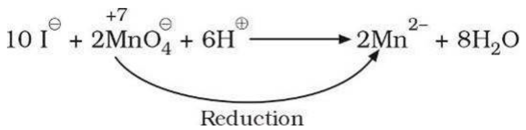


Oxidation and reduction of same species hence disproportion anion

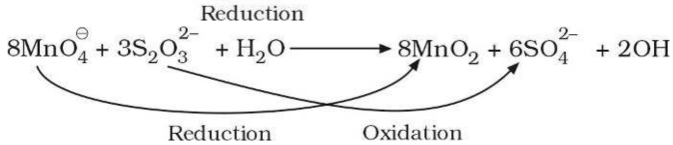
(B)



(C)



(D)



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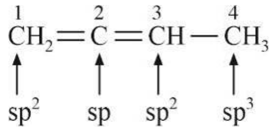
1.(A) 

2.(C) Carius Method is used for estimation of sulphur and halogens while Kjeldahl method is used for estimation of nitrogen.

3.(B) Sodium extract contain halogen, sulphur and nitrogen before adding $AgNO_3$, HNO_3 is added to remove sulphide and $\ddot{C}N$. Sulphide and $\ddot{C}N$ will be oxidized by HNO_3 so they cannot interfere.

4.(A) 1 is non-aromatic because of presence of sp^3 hybridized carbon and is non planar.

5.(4) Retarding factor $R_f = \frac{2}{5} = 0.4 = 4 \times 10^{-1}$

$$R_f = \frac{\text{distance travelled by given component}}{\text{distance travelled by solvent}}$$

6.(C) Both the statements are correct.

7.(B) Lassaigne's Test $\rightarrow$ N, S, P, Halogens

Cu(II) Oxide $\rightarrow$ Carbon is detected.

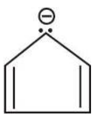
$AgNO_3 \rightarrow$ Halogens.

Sodium fusion extract gives black ppt with acetic acid and lead acetate - Sulphur.

8.(19) Number of moles of $N_2 = \frac{PV}{RT} = \frac{(758-14)}{760} \times \frac{30}{1000} \times \frac{1}{0.082 \times 287} = 0.00124$

Mass of nitrogen $= 0.00124 \times 28 = 0.03472$

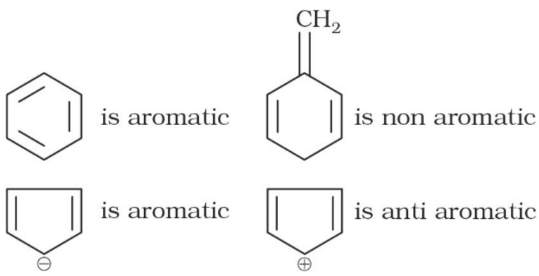
% Nitrogen $= \frac{0.03472 \times 100}{0.18} = 18.8\% = 19\%$

9.(C) 

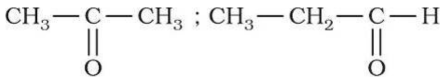
$4n + 2 = 6$

$n = 1$

10.(A)



11.(D) In chromatography technique the purification of compound is independent of physical state of pure compound.

12.(D) 

Shows functional group isomerism.

13.(D) Factual

Kjeldahl method is not applicable to compounds containing nitrogen present in ring, nitro group and azo group because nitrogen of these compounds does not change to $(NH_4)_2SO_4$ under these conditions.

14.(19) $g_{AgCl} = 0.3849\,g$

$$n_{AgCl} = \frac{g_{AgCl}}{M_{AgCl}} = \frac{0.3849}{107.87+35.5} = \frac{0.3849}{143.37}$$

$n_{AgCl} = 0.0026846$

$n_{\text{chlorinated compound A}} = n_{AgCl} = 0.0026846$

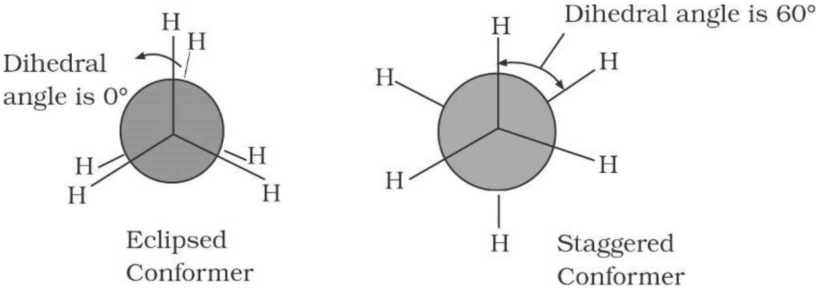
Also, $n_{\text{Cl in A}} = 0.0026846$

$\therefore \quad g_{\text{Cl in A}} = 0.0026846 \times 35.5\text{ g} = 0.0853\text{ g}$

$$\%\text{ chlorine in compound A} = \frac{0.0953}{0.5} \times 100 = 19.06\,\%$$

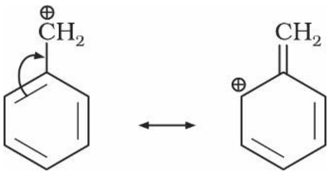
Nearest Integer is 19.

15.(A)

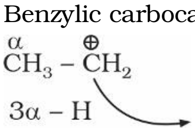


Eclipsed & staggered conformations are 3-D

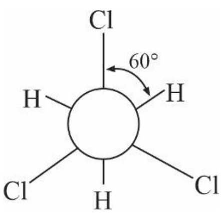
Spatial arrangement of atoms which results in rotating the ethane molecule along $C-C$, called as Rotamers.

16.(C) 

Benzylic carbocation stablised by Resonance effect

 stablised by Hyperconjugation effect.

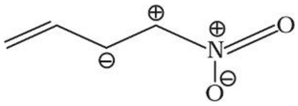
Strength of resonance effect is more than Hyperconjugation effect. So, option `3' is correct.

17.(60) 

18.(C) Statement I is correct because Hyperconjugation is a permanent effect.

Statement II is wrong because Hyperconjugation in $CH_3-CH_2^+$ involve overlapping of $C_{sp^3}-H$ bond with vacant 2p orbital of positively charged carbon atom.

19.(D) Sodium fusion extract can be used to defect presence of S, N, P and X (Halogens).

20.(A) 

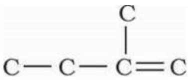
Is not correct because positive charges on adjacent atoms is highly unstable.

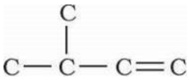
21.(12) % of nitrogen $=\dfrac{0.014\times N\times V\times 100}{\text{wt. of substance}}$

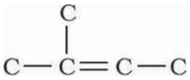
$\Rightarrow \quad 42=\dfrac{0.014\times 2\times V\times 100}{0.8} \quad \Rightarrow \quad V=\dfrac{42\times 0.8}{0.014\times 2\times 100}=12\text{ mL}$

22.(6) $C-C-C-C=C$ ...(1)

$C-C-C=C-C$ ...(2)

 ...(1)

 ...(1)

 ...(1)

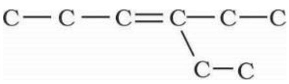
23.(D) Fact

24.(C) $CH_3-CH_2-CH=CH-\underset{\substack{\uparrow\\ sp^3}}{CH_2}-\ddot{N}H_2$

25.(D) $C-C-\underset{\substack{|\\ C}}{C}-C-C=C$ Optical active

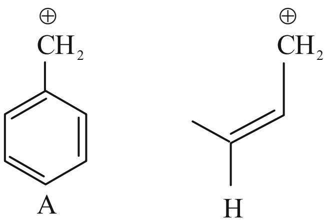
$C-C-C-\overset{\substack{C\\ |}}{C}-C=C$ Optical active

$C-C-\overset{\substack{C\\ |}}{C}=\overset{\substack{C\\ |}}{C}-C-C$ GI

 No GI

No optically active compound

26.(C)

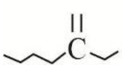
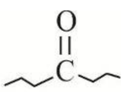


(A) (B)

Since, in compound (A) and (B), carbocation is in conjugation with π bond. Hence it is resonance stabilised carbocation.

27.(68) Percentage of bromine $=\dfrac{80}{188}\times 0.2397\times\dfrac{100}{0.15}=68\%$

28.(C) Fact $AgNO_3$

29.(C)  and 

Because the side chains of carbon are re-arranging around functional group $(-\overset{\substack{O\\ ||}}{C}-)$

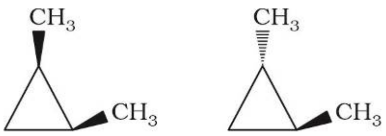
30.(42) Mass of S $= \frac{1.44}{233} \times 32 = 0.198\,\text{gram}$; % of S $= \frac{0.198}{0.471} \times 100 = 42 \cdot 038 \approx 42$

31.(D)

Cyclooctatetraene Tub shaped

It is non planar and hence non aromatic.

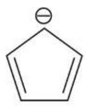
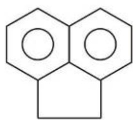
32.(C)



Cis Trans

(optically active)

Total 3 stereoisomers.

33.(CD)  and 

Both are aromatic in nature as these follow Huckel's rule of complete cyclic delocalisation of $(4n+2)\,\pi e^{-}s$ $[n = 1, 2, 3, \ldots]$

34.(7) $C_xH_yN_z + (2x + y/2)CuO \longrightarrow x\,CO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2}\right)Cu$

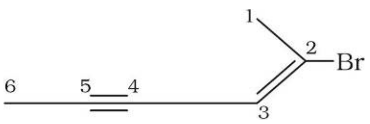
Value of y = 7

35.(D) Stability of conformer of n-Butane

(I) > (III) > (IV) > (II)

Potential energy order = (I) < (III) < (IV) < (II)

36.(B)



(2E) – 2 – bromo-hex-2-en-4-yne

37.(C) Propanol and propanone has higher difference between their boiling points hence they can be separated by simple distillation

Propanone $\to$ BP(56°C)

Propanol $\to$ BP(97°C)

38.(1125)

$C_7H_{17}N + \frac{45}{2}CuO \longrightarrow 7CO_2 + \frac{17}{2}H_2O + \frac{1}{2}N_2 + \frac{45}{2}Cu$

1 mole of N, N dimethylaminopentane requires $\frac{45}{2}$ moles of CuO and $\frac{57.5}{115}$ moles of N, N-dimethylaminopentane requires is $\frac{45}{2} \times \frac{57.5}{115}$ moles moles of CuO $= \frac{45}{2} \times \frac{57.5}{115}$

$= 11.25 = 1125 \times 10^{-2}$

39.(40) Molar mass of AgBr $= 188\,g/mol$

188 g AgBr contains 80g Bromine

0.188 g of AgBr contains $\frac{80}{188} \times 0.188\,g$ Bromine

Percentage of Bromine $= \frac{80 \times 0.188 \times 100}{188 \times 0.2} = 40\%$

40.(A) $\underset{\text{(Acidic)}}{FeCl_3} + K_4\left[Fe(CN)_6\right] \longrightarrow \underset{\text{(Blue Colour)}}{KFe\left[Fe(CN)_6\right]}$

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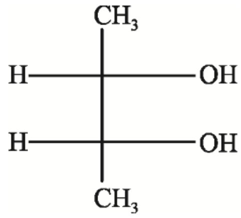
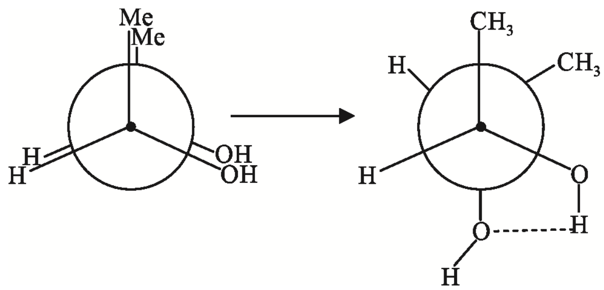
1.(B)



Meso-butane-2,3-diol



Most stable due to H-bonding

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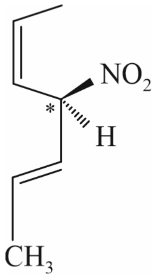
1.(C)  (optically active)

2.(D) $Sm^{2+} \rightarrow 4f^6$, $Er^{3+} \rightarrow 4f^{11}$ (Not isoelectronic)

$Yb^{2+} \rightarrow 4f^{14}$, $Lu^{3+} \rightarrow 4f^{14}$ (Isoelectronic)

$Eu^{2+} \rightarrow 4f^7$, $Tb^{4+} \rightarrow 4f^7$ (Isoelectronic)

$Tb^{2+} \rightarrow 4f^9$, $Tm^{4+} \rightarrow 4f^{11}$ (Not isoelectronic)

3.(22) Using ideal gas equation, $P_{N_2}V = n_{N_2}RT$

$P_{N_2} = (759 - 14.2) = (744.8)\,\text{mm Hg}$

$$\therefore \quad n_{N_2} = \frac{\left(\frac{744.8}{760}\right)(22.78)\times 10^{-3}}{0.082\times 280} = 0.97\times 10^{-3}\text{ mole}$$

Moles of N atoms $= 2(0.97)\times 10^{-3}$ mole

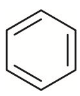
Mass of $N = 2(0.97)\times 14\times 10^{-3}$ gram

$$\%\text{ of } N = \frac{2(0.97)\times 14\times 10^{-3}}{0.125}\times 100 = 21.728\%$$

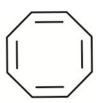
4.(A) $\underset{0.45\,g}{\text{Organic compound}} \xrightarrow[AgNO_3]{HNO_3} \underset{0.36\,g}{AgBr}$

$$\%Br = \frac{0.36}{188}\times\frac{80}{0.45}\times 100 = 34.04\%$$

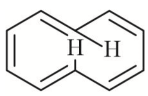
5.(42) $\%\text{ purity} = \frac{12.6}{30}\times 100 = 42\%$

6.(D)  $\rightarrow$ [6] Annulene (Aromatic)

(Planar)

 $\rightarrow$ [8] Annulene (Non-aromatic)

(Non- planar)

 $\rightarrow$ [10] Annulene (Non-aromatic)

(Non- planar)

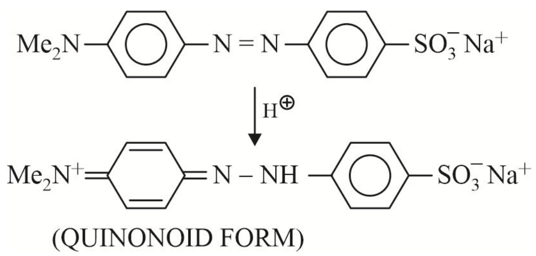
7.(B) Fact

8.(B) Fact

9.(D) Fact

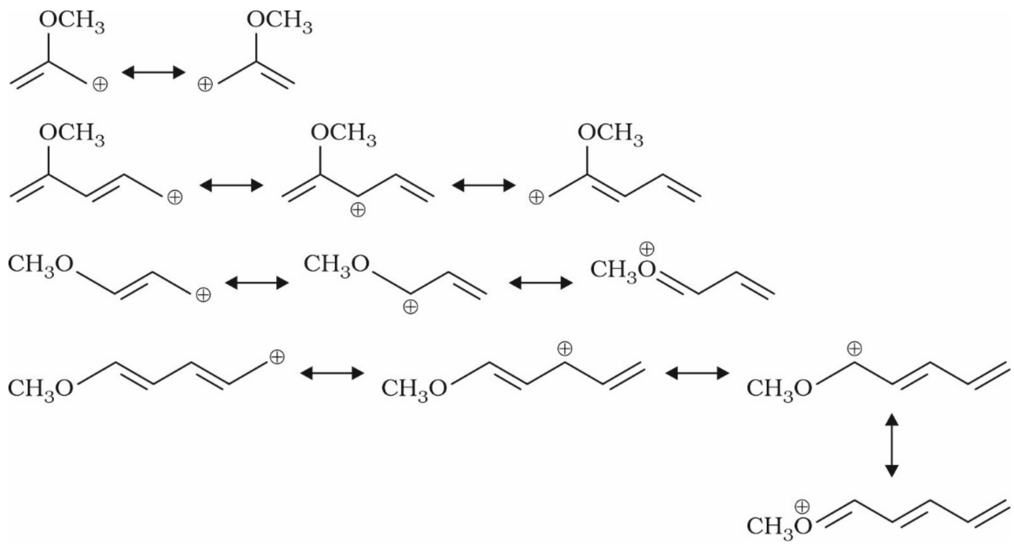
10.(2) $$\frac{R_{F_A}}{R_{F_B}} = \frac{\frac{2.08}{3.25}}{\frac{1.05}{3.25}} = \frac{2.08}{1.05} \approx 2$$

11.(A)



12.(56) $\%N = \frac{1.4(N_1V_1)}{\text{mass of organic compound}} \Rightarrow \%N = \frac{1.4(2.5\times2\times2)}{0.25} = 56$

13.(D)



More resonating structures, more stable species.

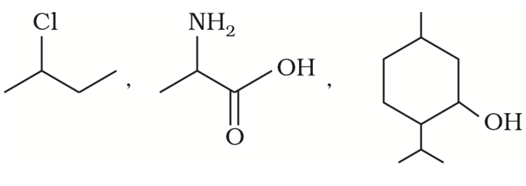
14.(64) $N \longrightarrow NH_3;\ 2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$

Mole of N = mole of $NH_3 = 2\times$Mole of $H_2SO_4 = 2\times\frac{12.5}{1000}\times1$

Mass of $N = 2\times\frac{12.5}{1000}\times1\times14$

% of $N = \frac{2\times12.5\times14\times1}{1000\times0.55}\times100 = 63.63$

15.(3) Compound having chiral carbon atom are asymmetric compound. Chiral carbon atom is also used as asymmetric carbon atom.



are asymmetric carbon containing compounds

16.(46) % of carbon $= \frac{12}{44}\times\frac{0.793}{0.492}\times100 = 43.95 \approx 44$

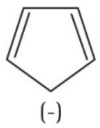
% of Hydrogen $= \frac{2}{18}\times\frac{0.442\times100}{0.492} = 9.98 = 10$

% of oxygen = 100 – (44 + 10) = 46

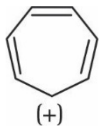
17.(C) 4-methyl-6-nitro-3-oxohept-4-enal

18.(C) Visualization agent as a component of mobile phase is not used to spot components of a mixture separated on thin layer chromatographic plate.

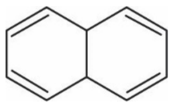
19.(B)



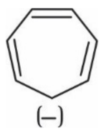
Aromatic : $6\pi e^-$ in conjugation



Aromatic : $6\pi e^-$ in conjugation.



Non-Aromatic



Anti-aromatic

20.(D) $Na_2S + \underset{\text{Sodium nitroprusside}}{Na_2[Fe(CN)_5NO]} \rightarrow \underset{\text{Purple}}{Na_4[Fe(CN)_5NOS]}$

21.(34) AgBr = 0.4 g ; Mass of Br $= \dfrac{\text{mass of AgBr}}{\text{Molar mass of AgBr}} \times \text{Atomic mass of Br} = \dfrac{0.4}{188} \times 80 = 0.17\text{g}$

$\% \text{Br} = \dfrac{0.17}{0.5} \times 100 = 34\%$

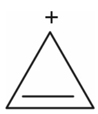
22.(40) 143.5g of AgCl contains = 35.5g of Cl

1 g of AgCl contains $= \dfrac{35.5}{143.5}$ = 35.5g of Cl

0.40 g of AgCl contains $= \dfrac{35.5}{143.5} \times 40$

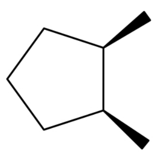
% of chlorine in compound $= \dfrac{35.5 \times .40}{143.5 \times .25} = 40$

23.(A)



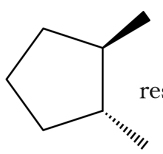
It contains $2\pi e^-$s in cyclic conjugation hence it is aromatic in nature and most stable.

24.(6)



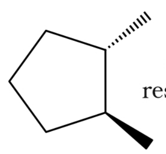
cis
meso

(1*R*, 2*S*)-1,2-dimethylcyclopentane



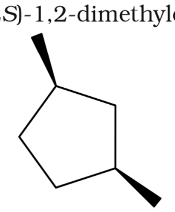
trans
resolvable

(1*R*, 2*R*)-1,2-dimethylcyclopentane



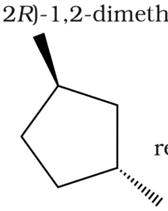
trans
resolvable

(1*S*, 2*S*)-1,2-dimethylcyclopentane



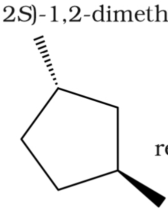
cis
meso

(1*R*, 3*S*)-1,3-dimethylcyclopentane



trans
resolvable

(1*R*, 3*R*)-1,3-dimethylcyclopentane



trans
resolvable

(1*S*, 3*S*)-1,3-dimethylcyclopentane

25.(18) Mol. wt. of $CO_2 = 12 + 16 \times 2 = 44$

Wt. of C in 0.2 gm $CO_2 = \dfrac{12}{44} \times 0.2 = \dfrac{2.4}{44} = 0.05454\text{ gm}$

% of C in $0°C = \dfrac{0.05454}{0.3} \times 100 = 18.18\% = 18$

26.(D) Nucleophilicity $\propto$ –ve charge density $\propto \frac{1}{\text{Electronegativity}}$; $NH_2^- > NH_3$

27.(D) Factual
Ethylidine chloride is 1, 1-Dichloroethane

28.(C) Mixture of o-nitrophenol and p-nitrophenol can be separated by steam distillation due to difference in boiling point o-nitrophenol is steam volatile and p-nitrophenol is less volatile due to intermolecular H bonding.

29.(C) In anti conformation the dihedral angle is 180°.

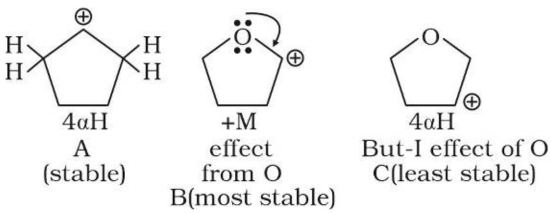
30.(14) Moles of N_2 evolved $= \frac{22.4\,\text{mL}}{22400\,\text{mL}} = 10^{-3}$ moles

Mass of $N_2(g) = 28 \times 10^{-3}$ gram

$\%$ of $N = \frac{28 \times 10^{-3}}{0.2} \times 100 = 14$

31.(A) Theory based

32.(A)



Stability order = B > A > C

33.(D) Mass of $CO_2 = 330\,\text{g}$

Number of moles of $CO_2 = \frac{330}{44} = 7.5$ moles

$n_{CO_2} = n_C = 7.5$ moles

mass of carbon = Number of moles $\times$ molar mass $= 7.5\,\text{mol} \times 12\,\text{g mol}^{-1}$

Mass of carbon = 90g

$\%$ of carbon $= \frac{\text{Mass of carbon} \times 100}{\text{Mass of organic compound}}$

$\%$ of carbon $= \frac{90}{120} \times 100 = 75\%$

% of hydrogen = 100 – % of carbon $= 100 - 75 = 25\%$

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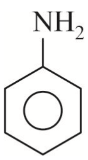
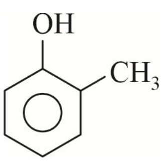
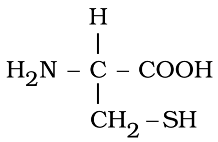
1.(D)



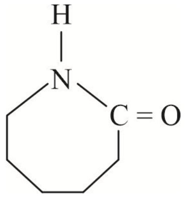
→ Blue colour in Lassaigne test (Presence of N)



→ Violet colour in $FeCl_3$ (Phenol derivative)



→ Blood red colour with sodium nitroprusside (Due to 'N' and 'S' both)



→ Blue colour in Lassaigne test (presence of N)

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Hydrocarbons	Class - XI | Chemistry

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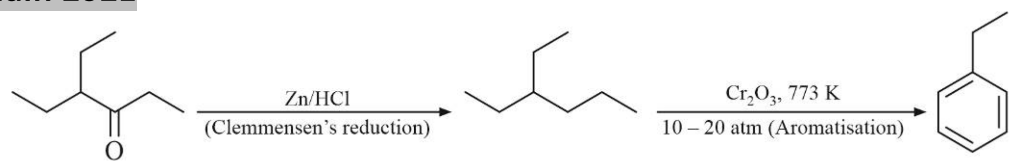
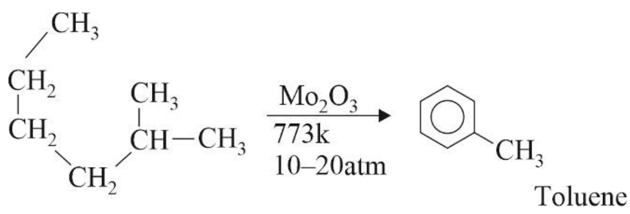
1.(C)

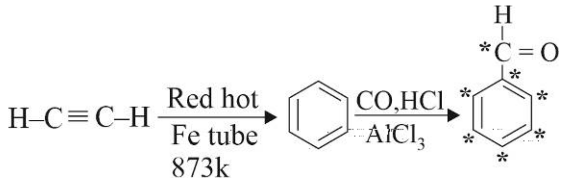


2.(D) $CH_3CH_2CH_3 \xrightarrow{Mo_2O_3} CH_3CH_2CHO$

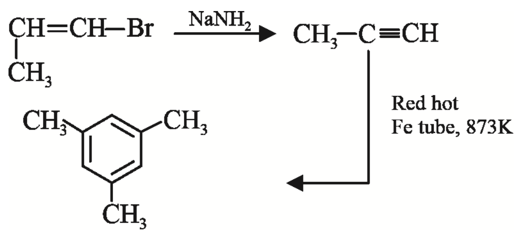
3.(D) This is catalytic aromatisation of alkanes.



4.(7)



5.(B)

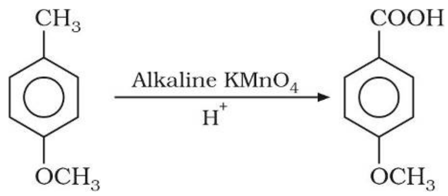


6.(A) The Lindlar catalyst is partially deactivated palladised charcoal.

7.(C) $CH_3-\underset{\underset{}{}}{\overset{CH_3}{\overset{|}{C}H}}-CH_2-CH_3 \xrightarrow{KMnO_4} CH_3-\overset{CH_3}{\overset{|}{\underset{OH}{\underset{|}{C}}}}-CH_2-CH_3$

n - Alkanes $\xrightarrow{KMnO_4}$ No reaction

8.(D)

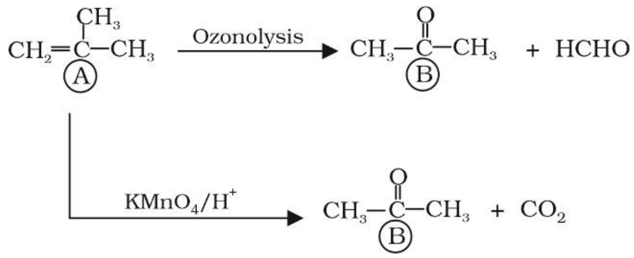


9.(B)
- **(a)** Alcoholic KOH is used for β-elimination reaction
- **(b)** $Pd / BaSO_4$ is Lindlar's catalyst
- **(c)** BHC is obtained by addition reaction on benzene of Cl_2
- **(d)** Polyacetylenes have much higher conductance than metal conductors, these can be used to prepare lighter and cheaper batteries.

10.(B) Since Iodination of alkanes is reversible in nature ∴ a powerful oxidizing agent like concentrated HIO_3 oxidises HI, thus removal of products at equilibrium will cause the reaction to shift in forward direction by Le-Ch atelier's Principle.

$$2HIO_3 + 10HI \longrightarrow 6I_2 + 6H_2O$$

11.(A)



12.(78) $C_6H_6 \xrightarrow[AlCl_3]{CH_3Cl} C_6H_5 - CH_3$

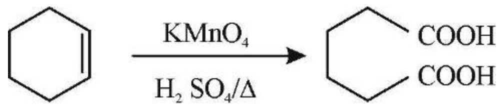
78g 92g

$78\,g\ C_6H_6$ gives $78\,g\ C_6H_6 = 92g$

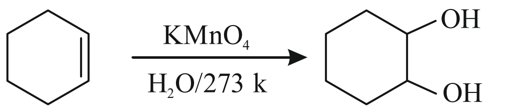
$10\,g\ C_6H_6$ gives $= \frac{92}{78} \times 10 = 11.8\,g$

$\%\ \text{yield} = \frac{\text{Product}}{\text{max product}} \times 100 = 78\%$

13.(D)



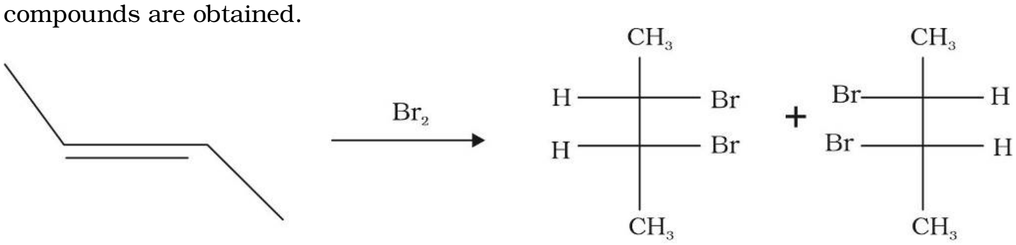
$KMnO_4 / H_2SO_4 / \Delta$ is strong oxidising agent



$KMnO_4 / H_2O / 273\,k$ is weak oxidising agent gives diol.

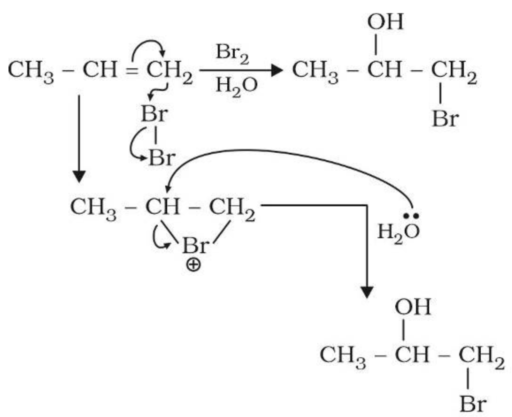
14.(D) Because in But-2-yne, there is no acidic hydrogen.

15.(D) Electrophilic addition of Br_2 over a double bond is an Anti addition and on using trans but-2-ene, meso compounds are obtained.



(Meso compounds)

16.(C)

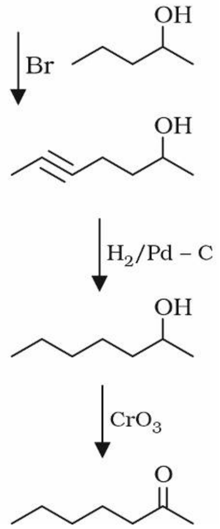


1-bromopropan-2-ol

In the above reaction Markovnikov rule is followed.

17.(B)

$CH_3-C\equiv C-H + NaNH_2 \longrightarrow CH_3-C\equiv C^{\ominus}Na^{\oplus}$



18.(3) Number of moles $= \dfrac{1.53}{M_2} = \dfrac{448}{22400}$

$\Rightarrow \quad M_2 = 76.5$

Formula of compound $C_nH_{2n-1}Cl$

$12n + 2n - 1 + 35.5 = 76.5$

$14n = 42 \quad \Rightarrow \quad n = 3$

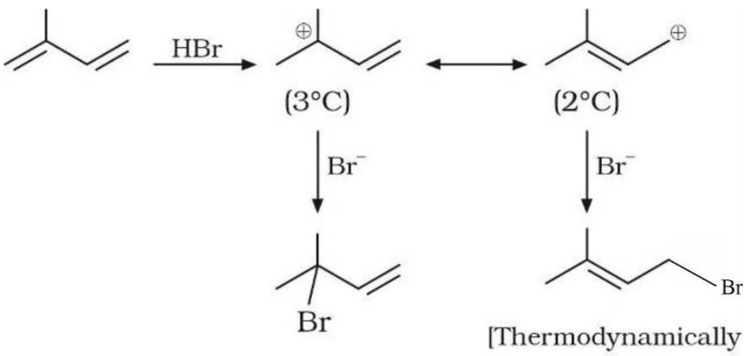
Number of carbon atoms = 3

19.(A) $CH_3-\underset{CH_3}{\overset{CH_3}{C}}-H \xrightarrow{Br_2/hv} CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Br$

(Excess)

Bromine is more selective

20.(A)



[Thermodynamically more stable]

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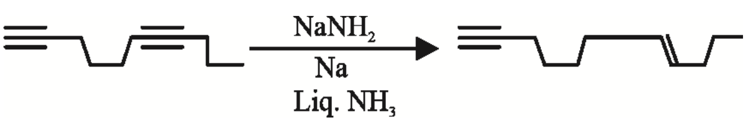
1.(B)



Alkyne on reaction with Alkali metal in liq NH_3 gives trans alkene.

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1.(3) $H_3C-C\equiv CH \xrightarrow[Clu_4]{B_2} H_3C-CBr_2-CHBr_2$

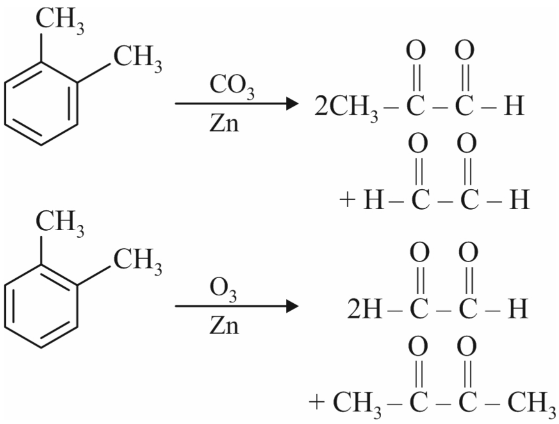
40 + 20 280

So from 240 g of $Br \rightarrow 280$

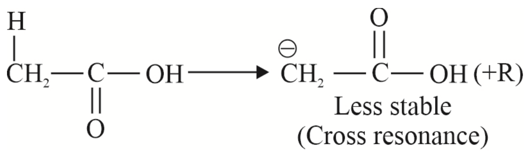
From 1g $= \dfrac{280}{240}$

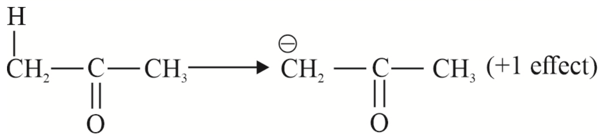
Yield is 27% $= \dfrac{280}{240}\times\dfrac{27}{100} = 0.315 = 3\times10^{-1}$

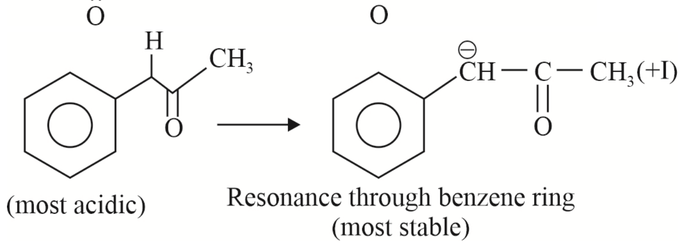
2.(C)



3.(C)

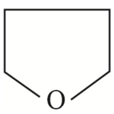
(A) 

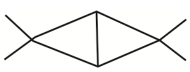
(B) 

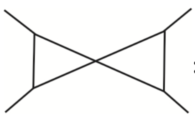
(C) 

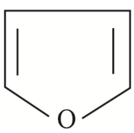
So it has least pK_a value.

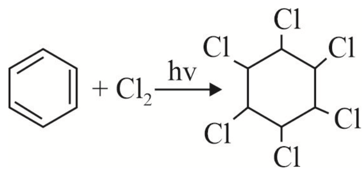
4.(C)

 : Non-planar heterocyclic Compound

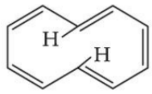
 : Bicyclo Compound

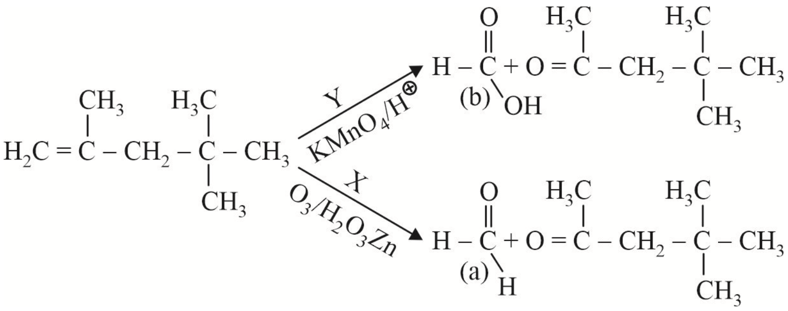
 : Spiro Compound

 : Aromatic Compound

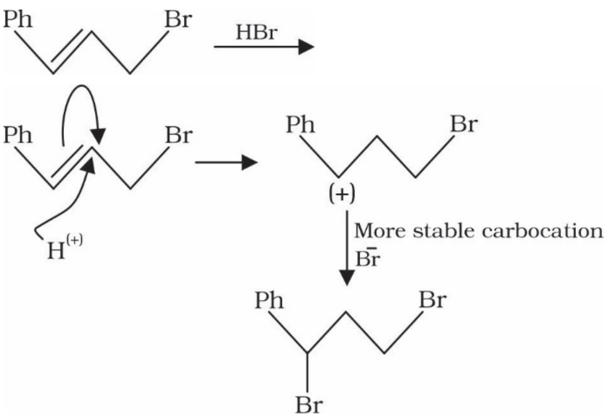
5.(6) 

6.(C) does not satisfy the condition of aromatic compound due to non-planarity of compounds.

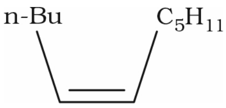


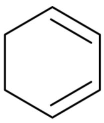
7.(D) 

8.(C)

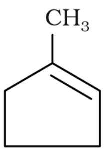


9.(C) $n-Bu-C\equiv CH \xrightarrow[\text{(acid base reaction)}]{\text{nBuLi}} n-Bu-C\equiv C^{-}Li^{+}$

$\xrightarrow[(S_N\ \text{reaction})]{n-C_5H_{11}Cl} n-Bu-C\equiv C-C_5H_{11} \xrightarrow[\text{Lindlar's Catalyst}]{H_2}$ 

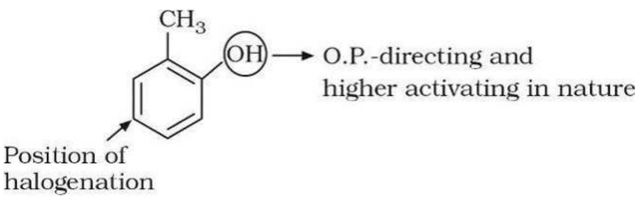
10.(D)  $\xrightarrow[(2)\ Zn-H_2O]{(1)\ O_3}$ $\begin{matrix} CH_2-CH=0 \\ | \\ CH_2-CH=0 \end{matrix}$ + $\begin{matrix} CH=0 \\ | \\ CH=0 \end{matrix}$

ethane 1,2 dicarbaldehyde glyoxal

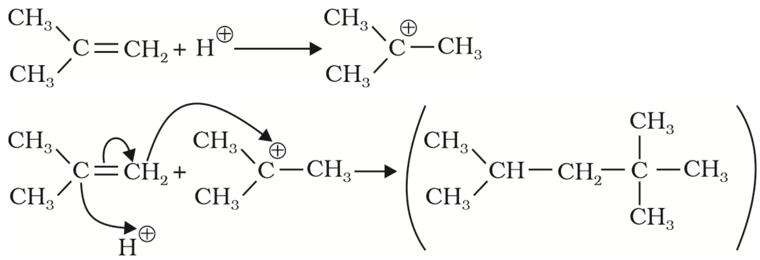


$\xrightarrow[(ii)\ Zn-H_2O]{(i)\ O_3}$ $CH_3-\overset{\overset{O}{||}}{C}-CH_2-CH_2-CH_2-CH=0$

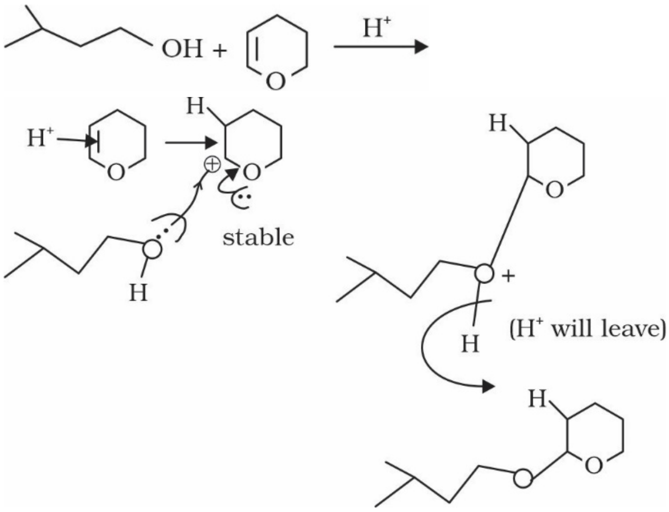
5–oxohexanal

11.(C) 

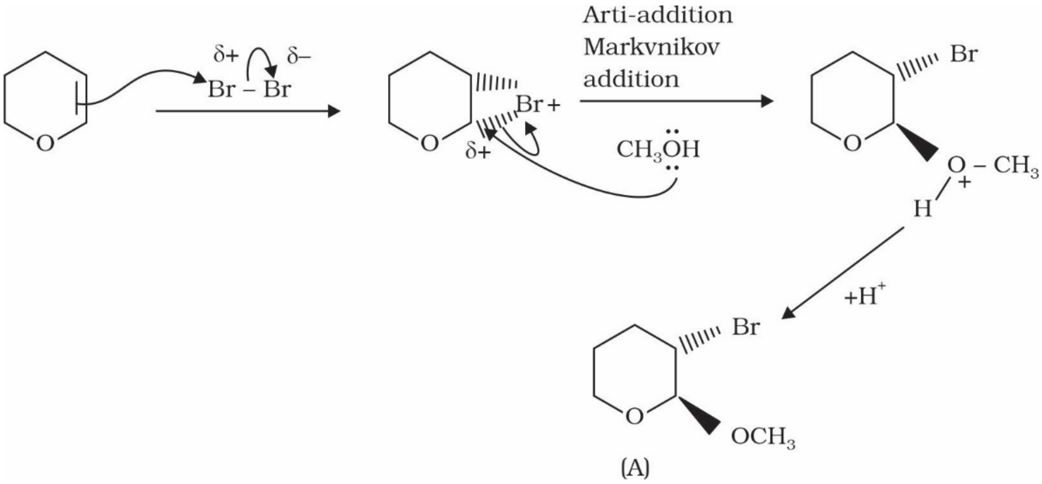
12.(B)



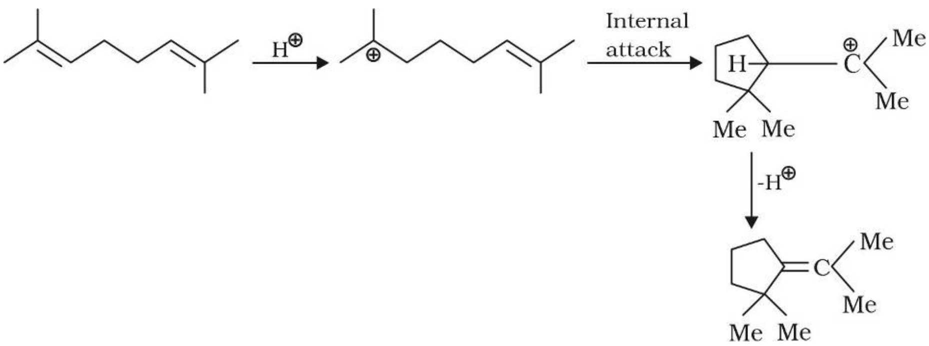
13.(D) The major product formed in the following reaction, is:



14.(A)



15.(2)



Solutions of Archive - JEE Main & Advanced

Hydrogen	Class - XI | Chemistry

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1.(D) Calgon is $Na_6P_6O_{18}$ sodium hexameta phosphate

$$Na_6P_6O_{18} \longrightarrow 2Na^+ + Na_4P_6O_{18}^{2-}$$

$$M^{2+} + Na_4P_6O_{18}^{2-} \longrightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+$$

(M = Mg, Ca) In solution

2.(C)

3.(B) Boiling point $D_2O > H_2O$ [Molecular weight]

Viscosity $D_2O > H_2O$

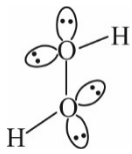
Heavy water is prepared by exhaustive electrolysis of water in NaOH.

4.(C) Tritium is radioactive isotope.

5.(C) Open book like structure NON planar.

$H_2O_2 \rightarrow$ can acts as O.A. as will as R.A.

$\rightarrow$ Miscible with water



6.(B) Dielectric constant of H_2O is higher than heavy water.

7.(D) The $H-O-H$ bond angle in water is 104.5° and hybridization of the oxygen atom is sp^3. The lone pair-lone pair repulsion is more than lone pair bond-pair, thus bond angle is below 109.5°.

8.(D) H_2O_2 can act as both oxidizing and reducing agent in basic medium and in hydrogen economy, the energy is transmitted in the form of dihydrogen.

9.(C) During boiling the soluble is converted into insoluble $Mg(OH)_2$

K_{sp} of $Mg(OH)_2 > K_{sp}$ of $MgCO_3$

10.(A) Cation exchanger contains acidic group like $-SO_3H$ or $-COOH$ and anion exchanger contains basic group like $-NH_2$.

11.(D) Radioactive isotope of hydrogen is ${}_1^3H$

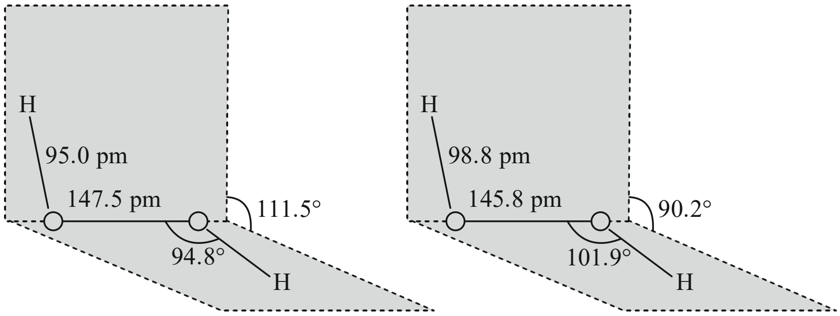
Number of neutrons = 2

Number of electrons = 1

12.(D) $t_{1/2(T)} = 12.33$ years

13.(A) H_2O_2 structure in gas phase, dihedral angle is 111.5°.

H_2O_2 structure in solid phase, dihedral angle is 90.2°.



(a) Gas phase (b) Solid phase

The change in dihedral angle is due to difference in intermolecular forces i.e., hydrogen bonding.

14.(D) In the synthesis of ammonia.

15.(B) Assertion is true.
O – D bond is more stronger than O – H bond.
Reason is false.

16.(B) Dissociation of H_2 at 2000K is only 0.081%.

17.(D) $C + H_2O \longrightarrow \underset{\text{(syn gas)}}{CO + H_2}$ (coal gasification)

Syn gas might contain a very small amount of CO_2 but not in equal amount

Statement-I is true but statement-II is false.

18.(D) The reactivity of deuterium is less than hydrogen. This is due to high bond dissociation energy of D_2.

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1.(C) SnH_4 is p-block Hydride. They are termed as Molecular Hydrides.

SnH_4 is non-Planar Molecule (Tetrahedral)

2.(5) $\underset{(+7)}{IO_4^-} + H_2O_2 \longrightarrow \underset{(+5)}{IO_3^-} + H_2O + O_2$

3.(C) **Clark's method :** In this method calculated amount of lime is added to hard water. It precipitates out calcium carbonate and magnesium hydroxide which can be filtered off.

$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 \downarrow + 2H_2O$

$Mg(HCO_3)_2 + 2Ca(OH)_2 \longrightarrow 2CaCO_3 \downarrow + Mg(OH)_2 \downarrow + 2H_2O$

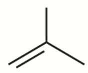
4.(C) Statement I is true but statement II is false

H_2O_2 can act as oxidizing agent in both acidic and basic medium.

Density of H_2O_2 at 298 K is higher than density of D_2O due to higher mass.

5.(A) Urea act as stabilizer for H_2O_2.

6.(C) High purity (>99.95%) dihydrogen is obtained by electrolysis of warm aqueous $Ba(OH)_2$ solution between Ni-electrodes

7.(D) $C_4H_8 \nearrow (A), \searrow (B) \xrightarrow[H^+]{KMnO_4} CO_2 + CH_3-\overset{\overset{O}{||}}{C}-CH_3 \longleftarrow$ 

2-Methylpropene

8.(C) H_2O_2 form O_2 if acts as reducing agent in both acidic and alkaline medium.

9.(A) $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O$

$Mg(HCO_3)_2 \xrightarrow{\Delta} Mg(OH)_2 + H_2O$

10.(B) Around 55% of hydrogen goes into the production of ammonia. Therefore, Nitrogen is the correct answer.

11.(A) **(A)** Correct - Both LiCl and $MgCl_2$ are soluble in ethanol

(B) Incorrect - Li and Mg do not form superoxide

(C) Correct - LiF is less soluble in water than other alkali metal fluorides because LiF has high lattice energy

(D) Incorrect - Li_2O is least soluble in water than other alkali metal oxides

12.(A) Industrial production of sodium hydroxide produce H_2 gas.

$2Na\ (amalgam) + H_2O \longrightarrow 2NaOH + H_2 + 2Hg$

13.(A) Baking soda $(NaHCO_3)$

When baking soda is heated, it becomes sodium carbonate and release of H_2O and CO_2 takes place, The CO_2 starves the fire of O_2.

$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + H_2O(\ell) + CO_2$

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s-Block Elements	Class - XI | Chemistry

JEE Main 2021

1.(C) $NH_3 + CO_2 + H_2O(A) \longrightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + CO_2(B) \longrightarrow NH_4HCO_3$

$(NH_4)HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3(C)$

2.(2) BeO and $Be(OH)_2$ are amphoteric species

3.(C) Refer NCERT

Metal	Li	Na	K	Rb	Cs
Colour λ / nm	Crimson Red 670.8	Golden Yellow 589.2	Violet 766.5	Red Violet 780	Blue 455.5

4.(D) Melting point α Lattice Energy $LE \propto \frac{Z^+Z^-}{r^+ + r^-}$

Lattice energy of LiF > LiCl

Lattice energy : MgO > NaCl

5.(1) Cs can be used as electrode in the photoelectric cell.

6.(B) NaH is a reducing agent.
The lone pair of electrons on nitrogen in pyridine is not delocalised, therefore, they make pyridine basic.

7.(C) Be is used in windows of X-rays
Mg is used in incendiary bombs and signals
Ca is used in extraction of metals
Ra is used in treatment of cancer

8.(B) Both $CaCl_2 \cdot 6H_2O$ and $MgCl_2 \cdot 8H_2O$ donot undergo dehydration on heating. BeO is amphoteric in nature and other oxides of second group are basic in nature.

9.(C)

List-I	**List-II**
$CaOCl_2$	Bleach
$CaSO_4 \cdot \frac{1}{2}H_2O$	Plaster of paris
CaO	Cement
$CaCO_3$	Antacid

10.(A) $2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + 2H_2O$

11.(B) Lithium is very small ion, therefore it can distort or polarize the anion electron cloud.

12.(C) **(a)** $Li \rightarrow$ (v) used in "white metal" bearings for motor engines.
(b) $Na \rightarrow$ (iii) Coolant in fast breeder nuclear reactor.
(c) $K \rightarrow$ (ii) absorbent of CO_2.
(d) $Cs \rightarrow$ (i) photoelectric cell.

13.(A) Solubility of alkaline earth metal hydoroxides increases down the group. $Ba(OH)_2$ is soluble in water.

14.(B) $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2(g)$

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

K is the most abundant element in the cell fluid

CsI is less soluble in water due to lesser hydration energy.

15.(C) $Ba = [Xe]6s^2$

16.(D) Down the group, thermal stability of carbonates increases and solubility in water decreases and hence $BaCO_3$ is highly stable and is insoluble in water. Both (A) and (R) are true and (R) is true explanation of (A).

17.(D) Except KO_2 (paramagnetic), all other given oxides are diamagnetic.

18.(A) Due to small size of Li^+ ion, its polarising power is maximum among alkali metals so its salt is highly hydrated.

19.(A) Na_2O_2 readily reacts with H_2O to give H_2O_2

$Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O_2$

20.(D) Order of solubility of Alkali metal fluorides in water : $LiF < NaF < KF < RbF < CsF$

21.(A) Gypsum is $CaSO_4 \cdot 2H_2O$

Dead burnt plaster is $CaSO_4$

Plaster of paris is $CaSO_4 \cdot \frac{1}{2}H_2O$

22.(A) $Ca(OH)_2 \xrightarrow{CO_2} CaCO_3 \downarrow \xrightarrow{CO_2} Ca(HCO_3)_2$

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1.(B) Gypsum is added to enhance the settling time of portland cement.

2.(C) Nitrates of alkali metal (except Li) decompose to give Nitrite and oxygen gas $NaNO_3 \rightarrow 2NaNO_2 + \frac{1}{2}O_2$.

Nitrate of Li shows abnormal behavior and diagonal relationship with magnesium and decomposes on heating to give NO_2 gas, O_2 and oxide.

$2LiNO_3 \rightarrow Li_2O + 2NO_2 + \frac{1}{2}O_2$

3.(B) $Li-Al$ alloy is used to make aircraft plates.
$Mg-Al$ alloy is also used for some aircraft construction.

Mg^{2+} ions are NOT important for cell membrane integrity.

Hence both statement (I) and (II) are false.

4.(B) Clark's Method Reaction

$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$

$Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow 2CaCO_3 + Mg(OH)_2 + 2H_2O$

5.(A) Low solubility of LiF in water is due to high lattice enthalpy.

6.(C) EGE

$Na = -53$ KJ / mole

$K = -48$

$Rb = -47$

$Cs = -46$

$Ar = +96$

$Kr = +96$

$I = -295$

$At = -270$

7.(D) **(I)** They act as Lewis acids.

(II) Beryllium hydroxide dissolves in excess of alkali to give a beryllate ion, $[Be(OH)_4]^{2-}$ just as aluminium hydroxide gives aluminate ion, $[Al(OH)_4]^-$.

8.(C) In LiF, size of Li^+ and F^- is nearly same, so LiF has high lattice enthalpy. So it is sparingly soluble in water.

Hydration energy $\alpha \frac{1}{\text{size of cation}}$

So, Li^+ will have high hydration energy among its group.
Hence, A is true and R is false

9.(B) $2BeCl_2 + LiAlH_4 \longrightarrow 2BeH_2 + LiCl + AlCl_3$

10.(C) In II group density decreases down the group till Ca and after that it increases.
Correct order of density is $Sr > Be > Mg > Ca$.

11.(A) Factual

12.(A)

Baking soda	–	$NaHCO_3$
Caustic soda	–	NaOH
Washing soda	–	$Na_2CO_3 \cdot 10H_2O$

13.(A) Li $\rightarrow$ 670.8 nm (Crimson Red)
Na $\rightarrow$ 589.2 nm (Yellow)
Rb $\rightarrow$ 780 nm (Red violet)
Cs $\rightarrow$ 455.5 nm (Blue)

14.(D) Isotopes are the atoms of same element having same atomic no but different atomic mass.

15.(B) $CuO + H_2 \rightarrow Cu + H_2O$

16.(2) $BeO + HF + NH_3 \rightarrow \left[Be(NH_3)_4\right]^{+2}$
So, oxidation state of beryllium is +2.

17.(D) $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$

18.(C) $2BeI_2 + LiAlH_4 \longrightarrow 2BeH_2 + LiCl + AlCl_3$

19.(D) Order of M.P.T
$Be > Ca > Sr > Mq$
1287°C 842°C 770°C 650°C

20.(D) Beryllium cannot be qualitatively confirmed by flame test.

21.(D) Mobility of ion $\propto \dfrac{1}{\text{Extent of hydration}} \propto \dfrac{1}{\text{Electrondensity}}$

So in Sr^{2+} least hydration.

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1.(D) **Q.** $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$

R. $Ca(OH)_2 + MgCl_2 \longrightarrow Mg(OH)_2 + CaCl_2$

S. $BaO_2 + HCl \longrightarrow BaCl_2 + H_2O_2$

P. $Mg(HCO_3)_2 + 2Ca(OH)_2 \longrightarrow Mg(OH)_2 + 2CaCO_3 + 2H_2O$

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p-Block Elements-I	Class - XI | Chemistry

JEE Main 2021

1.(A) Both Assertion A and Reason R are correct but R is not the correct explanation of A.

2.(C) PbO_2 is oxidizing agent, amphoteric and used in lead storage batteries.

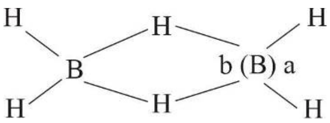
3.(B) $CO_2 + H_2O \longrightarrow H_2CO_3$

$C_3H_8(g) + 3H_2O(g) \longrightarrow 3CO + 7H_2$

$C + H_2O(g) \longrightarrow CO(g) + H_2(g)$

$CH_4(g) + H_2O(g) \longrightarrow CO(g) + 3H_2(g)$

4.(A)



Bond angle a > b

% s-character α bond angle

Thus terminal $B-H$ bonds have more s character and less 'p' character.

5.(A) C_{60} - It has 20 - 6 membered rings

12 - 5 membered rings

Carbon atoms are sp^2 hybridised hence 3 sigma bonds.

6.(B) $NaOH \Rightarrow$ Basic

$Be(OH)_2 \Rightarrow$ Amphoteric

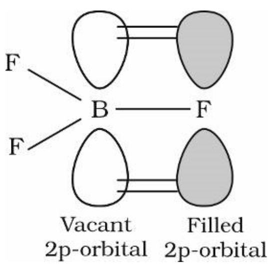
$Ca(OH)_2 \Rightarrow$ Basic

$B(OH)_3 \Rightarrow$ Acidic

$Al(OH)_3 \Rightarrow$ Amphoteric

7.(A) $\left[SiCl_6\right]^{2-}$ is unstable as it's unlikely for Si to accomodate six bulky Cl atoms around it.

8.(B)



In case of BF_3, $2p-2p$ overlapping is present while in $BCl_3\,(2p-3p)$, $BBr_3\,(2p-4p)$ and $BI_3\,(2p-5p)$ overlapping is present. Hence strongest back bonding i.e. strongest back donation will be in BF_3.

9.(A) Major component of Portland cement is Tricalcium silicate (>50%)

10.(5) Mohr's salt : $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$

The number of water molecules in Mohr's salt = 6

Potash alum : $KAl(SO_4)_2 \cdot 12H_2O$

The number of water molecules in potash alum = 12

So ratio of number of water molecules in Mohr's

Salt and potash alum $= \frac{6}{12} = \frac{1}{2} = 0.5 = 5 \times 10^{-1}$

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1.(D) $NaBH_4 + H_2O \longrightarrow NaOH + BH_3 + H_2$

$BH_3 + 3H_2O \longrightarrow H_3BO_3 + 3H_2$

$NaBH_4 + 4H_2O \longrightarrow NaOH + H_3BO_3 + 4H_2$

$NaOH + H_3BO_3 \longrightarrow Na[B(OH)_4]$

$LiBH_4 + 4H_2O \longrightarrow LiOH + H_3BO_3 + 4H_2$

$LiOH + H_3BO_3 \longrightarrow Li[B(OH)_4]$

$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$

$Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$

2.(A) Cs $\rightarrow$ Photoelectric cell
Ga $\rightarrow$ High temperature thermometer
B $\rightarrow$ Bullet proof vest
Si $\rightarrow$ Water repellent sprays

3.(C) Except Be other oxide of alkaline earth metals are basic in nature.

4.(B) Oxide of metals are basic, oxide of non-metals are acidic/neutral and oxide of Al is amphoteric.

5.(B) $Ba(N_3)_2 \rightarrow Ba + 3N_2$

6.(D) $(CH_3)_4Si$ – Silane
$(CH_3)Si(OH)_3$ – 2D Silicone
$(CH_3)_2Si(OH)_2$ – Chain Silicone
$(CH_3)_3Si(OH)$ – Dimeric Silicone

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1.(BCD)

(B) $2NaAlO_2 + CO_2 + 3H_2O \xrightarrow{60^\circ} 2Al(OH)_3 \downarrow + Na_2CO_3$

$2Al(OH)_3 \xrightarrow[1100^\circ C]{\Delta} Al_2O_3(pure) + 3H_2O$

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Solutions of Archive - JEE Main & Advanced

Environmental Chemistry	Class - XI | Chemistry

JEE Main 2021

1.(A) Ozone in troposphere generates photochemical smog.

2.(D) During anaerobic degradation of vegetation CH_4 is released, which is a source of global warming.

3.(A) Factual

4.(B) The pH of acid rain water ranges from $5-5.6$.

5.(B) CO_2, CH_4, water vapour are green house gases.

6.(B) Non-biodegradable wastes are generated by the thermal power plants e.g. Fly ash. Also biodegradable detergents leads to eutrophication.

7.(B) Reducing smog is a mixture of smoke, fog and SO_2.

8.(D) Allosteric inhibitor competes with enzyme's active site.

9.(C) Oxidising smog is produced during the day time in presence of O_3 .

10.(D) Reducing smog is mixture of smoke, fog and sulphurdioxide.

11.(B) Lack of nutrients in water bodies that prevent plant growth is not valid reason for eutrophication.

12.(D) The process in which nutrient enriched water bodies support a dense plant population, which kills animal life by depriving it of oxygen and results in subsequent loss of biodiversity is known as Eutrophication.

13.(C) **(a)** Carbon monoxide : cause decrease in amount of active Haemoglobin via formation of carboxy hemoglobin.

(b) Sulphur dioxide : Cause stiffness of floral buds.

(c) Polychlorinated biphenyls : Carcinogenic.

(d) Oxides of nitrogen : Metabolized by pyrus plant.

14.(B) Chlorofluoro carbons are get broken down by powerful UV radiations releasing chlorine free radical.

$$CF_2Cl_2(g) \xrightarrow{UV} \dot{C}l(g) + \dot{C}F_2Cl(g)$$

The $Cl^{\bullet}$ then react with stratospheric ozone

Hence statement-I is wrong

Atmospheric O_3 reacts with NO to produce

$NO_2(g)$ and $O_2(g)$

$$NO(g) + O_3(g) \longrightarrow NO_2(g) + O_2(g)$$

Hence statement-II is wrong

15.(C) Temp$\downarrow$ $\Rightarrow$ solubility of gas$\uparrow$

16.(D) Earlier $Cl_2C = CCl_2$ was used as solvent for dry cleaning agent but it is carcinogen.

Hence, liquified CO_2 is used, this results in less harm to ground water.

17.(D) NO_2 damages the leaves of plants and retard the photosynthesis.

18.(B) BOD value ≤ 5 is a criterion of clean water.

19.(D) Deposition of NH_4^+ is on wet surface and SO_2 is on Dry surface

20.(D) BOD values (in ppm) for clean water is less than 5 and for polluted water it is greater than 17

21.(D) $O_2(g) \xrightarrow{UV} O(g) + O(g)$

$O(g) + O_2(g) \xrightarrow{UV} O_3(g)$

22.(B) $CF_2Cl_2(g) \xrightarrow{UV} \dot{C}F_2Cl(g) + \dot{C}l(g)$

Chlorofluorocarbons (CFCs)

23.(D) Both (A) and (R) are true and (R) is true explanation of (A).

Presence of ozone, nitric oxide, acrolein formaldehyde and peroxyacetyl nitrate (PAN) in photochemical smog makes it oxidizing and due to this photochemical smog causes cracking of rubber.

24.(C) The optimum value of BOD is 5 ppm.

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1.(D) Sodium chlorate and sodium arsinite are used as herbicides. Aldrin and dieldrin are used as insecticides.

2.(D) Since eutrophication is result of excessive growth of weed, I water bodies, which consume dissolved oxygen of water bodies.

$\therefore$ Eutrophication decreases amount of dissolved oxygen in water bodies.

Polluted water has low value of dissolved oxygen, bu high value of BOD (Biological oxygen demand), since chemical and organic matter requires dissolved oxygen to get decompose.

3.(A) Both statements are true.

4.(B) **(A)** F^- ion concentration above 2 ppm causes brown mottling of teeth.

(B) The prescribed upper limit concentration of lead in drinking water is about 50 ppb. Lead can damage kidney, liver, reproductive system etc.

(C) Excessive sulphate (> 500 ppm) in drinking water causes laxative effect.

(D) Excess nitrate in drinking water can cause disease such as methemoglobinemia.

5.(C) $\dot{C}l + CH_4 \rightarrow \dot{C}H_3 + HCl$

6.(C) Factual

7.(D) $\underset{\text{Pollutant}}{2SO_2} + O_2 + H_2O \longrightarrow \underset{\text{(Acid rain)}}{2H_2SO_4}$

8.(A) H_2SO_4 is one of the constituents of acid rain and is responsible for damage of Taj Mahal.

9.(D) Photochemical smog result from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides.

10.(D) Sodium Arsenite is not a pesticide.
Rest are pisticides.

11.(B)

12.(A)

13.(C) Biological Oxygen Demand is defined as the amount of molecular oxygen required for the biological oxidation of organic matter in water and on average, the oxygen demand for organic waste material which are aerobically degradable.

Proteins water $\rightarrow$ below 1 mg L^{-1}

Moderately polluted water $\rightarrow 2 - 8$ mg L^{-1}

Treated sewage water $\rightarrow 20 -$ mg L^{-1}

Extent of pollution $\propto$ BOD value.

14.(A) factual
Eutrophication of water body leads to loss of biodiversity

15.(C) Clean water would have BOD value of less than 5 ppm,
Whereas Highly polluted water could have BOD value of 17 ppm or more.
Amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water, is called biochemical oxygen demand (BOD)

$\Rightarrow$ Assertion is correct but R is not correct.

16.(D) Greenhouse gases $\Rightarrow$ CH_4, H_2O, O_3, N_2O, CO_2 fluorinated gases (SF_6, NF_3).

N_2 does not cause global warming.

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1.(1) Octahedral voids are present at edge centres and body centres in fcc unit cell.

Total number of octahedral voids $= \left(\frac{1}{4} \times 12\right) + (1 \times 1) = 4$

In fcc, each unit cell has 4 atoms

Number of octahedral voids per lattice site in a lattice is $\frac{4}{4} = 1$ (Answer)

2.(9077) Density $= \frac{Z \times M}{a^3 \times N_A}$

$$= \frac{4 \times 63.54}{\left(3.596 \times 10^{-10}\right)^3 \times 6.02 \times 10^{23}}$$

$$= \frac{4 \times 63.54 \times 10^{-3}}{280.03 \times 10^{-7}}$$

$$= .9077 \times 10^4 \qquad = 9077 \text{kg} / \text{m}^3$$

3.(8) CN of atom in body centered cubic structure is 8.

4.(15) No. of atoms in 0.581 g Ga

$$= \frac{0.581}{70} \times 6.023 \times 10^{23} = 0.05 \times 10^{23} = 5 \times 10^{21}$$

In hcp unit cell, there are 6 atoms, 6 OHVs and 12 THVs

$\therefore$ In 1 hcp unit cell there are 18 voids.

$\therefore$ No. of unit cell $= \frac{5}{6} \times 10^{21}$

No. of voids $= \frac{5}{6} \times 10^{21} \times 18 = 15 \times 10^{21}$

5.(A) Mn_3O_4 : paramagnetic

Na_2O, MgO, SiO_2 all are diamagnetic due to absence of unpaired electrons

6.(B) Covalent solids (Network solids) are hard substances with high melting point (due to stronger forces of attraction).

They are generally bad conductors of electricity due to absence of unpaired electrons (both in solid and molten state) except graphite.

7.(33) for bcc lattice $\sqrt{3}a = 4r$

$$r = \frac{\sqrt{3} \times 27}{4} \text{Å}$$

For same metal and fcc lattice

$$\sqrt{2}a = 4r$$

$$a = 2\sqrt{2}r$$

$= \frac{2 \times \sqrt{2} \times \sqrt{3} \times 27}{4}$

$a = 33.06\text{Å}$

So the answer will be = 33Å

8.(5) KBr is doped with $SrBr_2$

or

$2K^+$ is replaced with one Sr^{2+}

So number of Sr^{2+} ion $=$ Number of vacancies

Mole % of $SrBr_2 = 10^{-5}$

Number of vacancy $= \frac{10^{-5}}{100} \times \frac{N_A}{119} = 10^{-7} \times \frac{6.023 \times 10^{23}}{119} = 5.06 \times 10^{14}$

9.(D) hcp ; z = 6

TV = 2 × 6 = 12

But occupied are $2/3^{rd}$

$12\frac{2}{3} = 8$

$M_8A_6 = M_4A_3$

10.(C) Statements [A], [C] and [D] are correct while statements [B] and [E] are wrong because crystalline solids are anisotropic and Amorphous solids DO NOT have definite heat of fusion.

11.(106)

$\rho = \frac{\text{mass}}{\text{vol}}$

$7.62 \frac{MM / 6.022 \times 10^{23} \times 4}{\left(0.4518 \times 10^{-7}\right)^3}$

$MM = 106$

12.(8) Diamond has FCC lattice

No. of carbon atom per FCC

Unit cell is $\frac{1}{8} \times 8 + \frac{1}{2} \times 6 \;\; = 1 + 3 = 4$

50% tetrahedral void occupied by carbon atoms.

Total tetrahedral void is FCC = $2n = 2 \times 4 = 8$

50% of 8 tetrahedral void = 4

Hence 4 + 4 = 8 carbon atom present per unit cell in diamond.

13.(1) In CCP,

Effective no. of anion = $\frac{1}{8} \times 8 + \frac{1}{2} \times 6 = 4$

Effective no. of cation = $\frac{1}{4} \times 12 + 1 = 4$

= $A_4B_4 = AB$

14.(A)

Diamagnetism	NaCl
Ferrimagnetism	Fe_3O_4
Paramagnetism	O_2
Antiferromagnetism	MnO

15.(D) Frenkel defect is not responsible for colour and F-centers.

16.(C) $a \neq b \neq c$

$\alpha = \gamma = 90°$

$\beta = 120°$ $\Rightarrow$ Monoclinic

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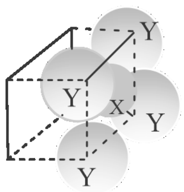
1.(B) $a = 2r_y$ ... (i)

$2\left(r_x + r_y\right) = a\sqrt{2}$ ... (ii)

$2\left(r_x + r_y\right) = 2\sqrt{2}\, r_y$

$r_x = \left(\sqrt{2} - 1\right) r_y$



Z for $X = 3$

Z for $Y = 1$

$$PE = \frac{3 \times \frac{4}{3}\pi r_x^3 + \frac{4}{3}\pi r_y^3}{a^3} = \frac{\frac{4}{3}\pi\left(3r_x^3 + r_y^3\right)}{a^3} = \frac{\frac{4}{3}\pi ry^3\left[3\left(\sqrt{2}-1\right)^3 + 1\right]}{\left(2r_y\right)^3} = \frac{\frac{4}{3}\pi\left(3 \times 0.0709 + 1\right)}{8} = 0.63$$

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1.(D) Vacancy defect decreases the density of the substance.

2.(3) A : Effective number of atoms in CCP = 4

B : octahedral voids = 4

If two atoms from opposite faces are removed

Effective number of atoms A = 4 – 1 = 3

Formula of compound A_xB_y

A_3B_4

3.(1) On solving for a (edge length) using density, a = 2.08 × 10^{-8} cm = 2.08 × 10^{-10} m

Distance between Na^+ and Cl^- = a/2 = 1.04 × 10^{-10} m = ______ × 10^{-10} m

4.(43) $X \to 6 \quad Y \to \frac{2}{3} \times 2 \times 6 = 8$

$\%X = \frac{6}{14} \times 100 = 42.8 \simeq 43\%$

5.(566) $a = 2r_+ + 2r_-$

$= 2(102) + 2(181)$

$a = 566\,pm$

6.(87) Density, $D = \frac{ZM^\circ}{N_A a^3}$

Here $Z = 4,\ N_A = 6.02 \times 10^{23},\ a = 4 \times 10^{-8}cm,\ D = 9.03\,g/cc$

$\Rightarrow \quad M^\circ = \frac{DN_A a^3}{Z} = \frac{9.03 \times 6.02 \times 10^{23} \times 64 \times 10^{-24}}{4} = 86.9\,g/mole$

7.(22) M is body certred cubic, $\therefore\ Z = 2$

Let mass of 1 atom of M is A

Edge length $= 300$ pm

Density $= 6g/cm^3$

$\therefore 6g/cm^3 = \frac{Z \times A}{(300 \times 10^{-10})^3} = \frac{2 \times A}{27 \times 10^{-24}}$

$A = 81 \times 10^{-24} g$

$\therefore$ Atomic mass $= 48.6g$

$\therefore$ Mole in $180g = \frac{180}{48.6} = 3.7$ moles

Atoms of $M = 3.7 \times 6 \times 10^{23}$

$= 22.22 \times 10^{23}$ atoms

8.(A) Both statement I and statement II are correct.

O_2, Cu^{+2} and Fe^{+3} all are paramagnetic in nature due to presence of unpaired e^- and hence are weakly attracted by magnetic field and are magnetized in same direction as magnetic field.

NaCl and H_2O are diamagnetic in nature and will be weakly magnetized in opposite direction to magnetic field.

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1.(2) $\Delta T_f = 0.93°C$

$K_f(H_2O) = 1.86\ K\ kg\ mol^{-1}$

$n_{benzoic\ acid} = \frac{12.2}{122} = 0.1\ mol$

$\Delta T_f = iK_f m$

$0.93 = i \times 1.86 \times \frac{0.1}{100} \times 1000$

$0.93 = i \times 1.86$

$i = 0.5$

$x\ C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_x$

$i = \frac{\text{Number of molecules after association}}{\text{Number of molecules before association}}$

$0.5 = \frac{1}{x}$

x = 2 (Answer)

2.(18)

$$\underset{\frac{1 \times 224}{0.0821 \times 298} = 9.15\ m\ mol}{SO_2} + \underset{0.1\ M,\ 100\ ml \Downarrow 10\ m\ mol}{2NaOH} \rightarrow Na_2SO_3 + H_2O$$

$\Rightarrow$ NaOH is limiting reagent so 5 m mol of Na_2SO_3 will be formed.

For dilute solution

$\Rightarrow \frac{p° - P_s}{p°} = \frac{i \cdot n_B}{n_A} \Rightarrow \frac{p° - p_s}{24} = 3 \times \frac{5 \times 10^{-3}}{\left(\frac{36}{18}\right)} \Rightarrow p° - p_s = 18 \times 10^{-2} \Rightarrow x = 18$

3.(3)

	AB	$\rightleftharpoons$	A^+	+	B^-
	1		0		0
	$1 - .75$		.75		.75

$\alpha = .25 + .75 + .75 = 1.75$

$\Delta T_b = k_b \times i \times m$

$2.5 = 1.75 \times 0.52 \times m$

$m = \frac{2.5}{1.75 \times .52} = 2.747$

4.(375) $A_2B_3 \rightarrow 2A^{+3} + 3B^{-2}$

No of ions $= 2 + 3 = 5$

$i = 1 + (n-1)\alpha = 1 + (5-1) \times 0.6 = 3.4$

$\Delta T_b = k_b \times m \times i = 0.52 \times 1 \times 3.4 = 1.768°C$

$T_b = 373 + 1.768 = 374.768 = 375K$

5.(1) $T°_f = 5.5°C$

$\Delta T_f = K_f m$

$= 5.12 \times \dfrac{10 \times 1000}{58 \times 200}$

$\Delta T_f = 4.41$

$(T_f)_{solution} = 5.5 - 4.41 = 1.09°C$

6.(36) $Cl - CH_2 - COOH \xrightarrow{H_2O} Cl - CH_2 - COO^- + H^+$

$\Delta T_f = i \times k_f \times m$

$$0.5 = (1 - \alpha + 2\alpha) \times 1.86 \times \frac{\left(\frac{9.45}{94.5}\right)}{\left(\frac{500}{1000}\right)}$$

$1 + \alpha = 1.344$; $\alpha = 0.344$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{\left(\frac{9.45}{94.5}\right)}{\left(\frac{500}{1000}\right)} \times \frac{(0.344)^2}{0.656} = 0.036 = 36 \times 10^{-3}$$

$x = 36$

7.(100) $2A \rightleftharpoons A_2$

	$2A$	A_2	
$t = 0$	a_0	–	$n_i = a_0$
$t = t_f$	$a_0 - 2x$	x	$n_f = a_0 + x$

$\Delta T_b = i K_b m$

$0.52 = i(0.52)[2]$

$i = 0.5$

$i = \dfrac{n_f}{n_i}$

$0.5 = \dfrac{a_0 + x}{a_0}$

$0.5a_0 = a_0 + x$

$x = 0.5a_0$

$\% \text{ association} = \dfrac{2x}{a_0} \times 100 = \dfrac{2(0.5a_0)}{a_0} \times 100 = 100\%$

8.(64) 100 molal solution means, 100 moles of solute in 1000 gm water.

$n_{H_2O} = \dfrac{1000}{18} = 55.55$

$\chi = \dfrac{100}{100 + 55.55} = 0.6428 = 64.28 \times 10^{-2}$

9.(1389)

$p = K_H \chi_{O_2}$

$$20 = 8 \times 10^4 \times \left(\frac{n_{O_2}}{n_{H_2O}}\right)$$

$n_{O_2} = \frac{20}{8 \times 10^4} \times n_{H_2O} = \frac{20}{8 \times 10^4} \times 55.55 = 138.87 \times 10^{-4} = 1388.7 \times 10^{-5} = 1389 \times 10^{-5}$

Correct Answer = 1389

10.(9) Molality of $KOH = 6.50$ molal

Density = 1.89g/ml

$m = \left[\frac{M \times 1000}{1000 \times d - M \times \text{molar mass solute}}\right]$ M = molarity

$6.5 = \frac{M \times 1000}{1000 \times 1.89 - M \times 56}$

$6.5 \times 1890 - M \times 56 \times 6.5 = M \times 1000$

$\frac{6.5 \times 1890}{1364} = M$

$M = 9.00$

11.(106)

AB_2	$\rightleftharpoons$	A^{+2}	+	$2B^-$
1		0		0
$1-0.1$		0.1		0.2

$i = 1.2$

$\Delta T_b = 1.2 \times .5 \times 10 = 6$

$T_b - T_b^0 = 6$

$T_b = 6 + 100 = 106°C$

12.(85) $\underset{1-\alpha}{K_4[Fe(CN)_6]} \rightleftharpoons \underset{4\alpha}{4K^+} + \underset{\alpha}{[Fe(CN)_6]^{4-}}$

$i = 1 + 4\alpha = 2.6$

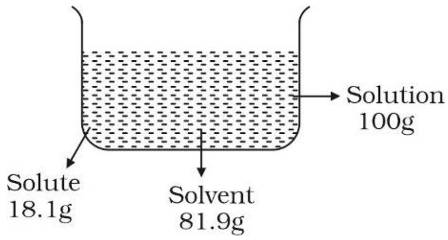
$K_4[Fe(CN)_6]$: $\Delta T_b = iK_b m$

$\Delta T_b = 2.6 \times K_b \times 1$ .... **(i)**

Non electrolytic solute : $\Delta T_b = K_b m$

$2.6 \times K_b \times 1 = K_b m$ .... **(ii)**

Let mass of solution $= 100g$



Molality $= \frac{18.1/x}{81.9 \times 10^{-3}}$ $\Rightarrow$ $2.6 = \frac{18.1/x}{0.0819}$ $\Rightarrow$ $x = 85g / mole$

13.(50) $\Delta T_f = 3.885$

$K_f = 1.85 \text{ K kg mol}^{-1}$

$\Delta T_f = ik_f \ m$

3.885 = i (1.85) (2)

i = 1.05

For dissociation of acid

$$\begin{array}{cccc} HA & \rightleftharpoons H^+ & + & A^- \\ 1 & - & & - \\ 1-\alpha & \alpha & & \alpha \end{array}$$

$$i = \frac{1-\alpha+\alpha+\alpha}{1} = 1+\alpha$$

$1.05 = 1+\alpha$

$\alpha = 0.05$

$\alpha = 50\times10^{-3}$

14.(15) As we know $\pi = CRT$

$\Rightarrow \quad 2.42\times10^{-3} = C\times0.083\times300$

$\Rightarrow \quad C = 10^{-4}$

$\therefore \quad$ Molar mass $= 14.6\times10^{-4} = 15\times10^{-4}$

15.(125)

Van't Hoff factor for dissociation : $i_1 = 2$

Van't Hoff factor for dissociation : $i_2 = 0.5$

$$i_{avg} = \frac{2+0.5}{2} = 1.25 = 125\times10^{-2} = 125$$

16.(25) $P.P. = K_H.X_{(l)}$ – Henry Law

$0.835 = 1.67\times10^3\times X_{CO_2}$

$$\frac{0.835}{1.67}\times10^{-3} = \frac{n_{CO_2}}{n_{CO_2}+n_{H_2O}}$$

$$0.5\times10^{-3} = \frac{n_{CO_2}}{n_{CO_2}+\frac{900}{18}}$$ [assume :- $n_{CO_2}+50\approx50$]

$\left(0.5\times10^{-3}\right)\times50 = n_{CO_2}$

Milli moles of $CO_2 = 0.5$

17.(250) $\Delta T_b = K_b\times m$

$\Rightarrow \quad 0.6 = 5\times\frac{3}{M_0}\times\frac{1000}{100} \quad \Rightarrow \quad M_0 = 250$

18.(C) Lowering of freezing point = colligative property more no. of solute $\Rightarrow$ more lowering of freezing point

$Al_2(SO_4)_3 \rightarrow 2Al^{+3}+3SO_4^-$

5 times or $i = 5$

19.(78) y_A is mole fraction of benzene in vapour phase

$$y_A = \frac{P_A}{P_{Total}}$$

$P_A = P_A^0\chi_A$

$P_{Total} = P_A^0\chi_A + P_B^0\chi_B$

According to the questions,

$P_A^0 = 70$ Torr

$P_B^0 = 20$ Torr

$\chi_A = 0.5$

$\chi_B = 0.5$

Substituting values,

$$y_A = \frac{70\times0.5}{(70\times0.5)+(20\times0.5)}$$

$$y_A = 77.7\times10^{-2}$$

20.(1) $P_A^\circ = 90\text{mm Hg}\ P_B^\circ = 15\text{mm Hg}$

$X_A + X_B = 1$ $\quad X_A = 0.6$ $\quad X_B = 0.4$

$P_T = P_A^\circ X_A + P_B^\circ X_B = 90(0.6)+15(0.4) = 60\text{mm Hg}$

Now in Gaseous form $\rightarrow$ mole fraction Y_B

$P_B = P_B^\circ X_B = P_T Y_B$

$$Y_B = \frac{15\times0.4}{60} = 0.1 = 1\times10^{-1}$$

Thus x = 1

21.(20) $\text{Molarity(M)} = \frac{n_{solute}}{V_{soltuion}}$

$n_{solute} = \frac{6.3}{126}$

$V_{solution} = 0.25$

$$m = \frac{6.3}{126\times0.25} = 0.2$$

$= 20\times10^{-2}$

22.(13) $\Delta T_b = k_b \times m \times i$

In Acetone,

$$M_{\text{organic acid}} = \frac{1.7\times1.22\times1000}{0.17\times100} = 122$$

In benzene, $\Delta T_b = \frac{2.6\times1.22\times1000}{244\times100} = 0.13$

$$\Delta T_b = 0.13 = 13\times10^{-2}$$

23.(C) Van't Hoff factor of $KHSO_4$ is 2, for rest it is 1

$\Delta T_f = iK_f m$

Greater the value of i, greater is the depression in freezing point

24.(271) $\Delta T_f = k_f.m$

$m = \left(\frac{\frac{40}{180}}{0.2}\right) = \left(\frac{10}{9}\right)$ [as density of water is 1 gm/ml $\therefore$ 200 ml water $= 200\,\text{gm}$]

$$\Delta T_f = 1.86\times\frac{10}{9}$$

Freezing point of solution $= 273.15 - \frac{18.6}{9} \approx 271\text{K}$ (approximately)

25.(518) For 0.75 m solution,

Mass of sucrose = $342\times0.75 \Rightarrow 256.5\,\text{g}$

$0.75\,m \equiv 0.75$ mole in 1000 g solvent

Mass of solution = 1000 + 256.5 = 1256.5 g

Since, 1256.5 g solution contains 256.5 g sucrose

1000 g solution contains $\frac{256.5}{1256.5} \times 1000\,g$ sucrose $= 204.138\,g$

So, mass of solvent = $1000 - 204.138 \Rightarrow 795.862\,g$

$\Delta T_f = k_f\, m$

where $\Delta T_f = 4°C$

$4 = 1.86 \times \frac{204.138 \times 1000}{342 \times w_A}$

$w_A = 277.556\,g$

Hence amount of ice that will be separated out = $(795.862 - 277.556)g$

$= 518.306\,g$

$= 518\,g$ (Nearest integer)

26.(269) $m = \frac{w \times 1000}{M_2 \times W}$

$m = 2.14$

$\Delta T_f = m \times K_f$

= 2.14 × 1.86 = 3.98

$\Delta T_f \simeq 4K$

$T_f = T_f^{\circ} - \Delta T_f = 273 - 4 = 269$ K

27.(19) $X_A = \frac{1}{3}$; $X_B = 2/3$

$P = P_A^{\circ} x_A + P_B^{\circ} x_B = 21 \times \frac{1}{3} + 18 \times \frac{2}{3} = 7 + 12 = 19\,kPa$

28.(4) As 0.1 M C_2H_5OH is non-dissociative and rest all salt given are electrolyte so in each case effective molality > 0.1, so each will have lower freezing point.

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1.(100.1) $AgNO_3 \longrightarrow Ag^+ + NO_3^-$

$\Delta T_b = iK_b m$

$i = 2$

$\Delta T_b = 2 \times 0.5 \times 0.1 = 0.1$

$T_b = 100 + 0.1$; $(T_b)_A = 100.1$

2.(2.5) $2AgNO_3 + BaCl_2 \longrightarrow 2AgCl \downarrow + Ba(NO_3)_2$

0.1v 0.1 v

- 0.05v 0.1 v 0.05v

$\Delta T_b = iK_b m = \left(\frac{0.15v + 0.15v}{2v}\right) \times 0.5 = \frac{0.3}{2} \times 0.5 = 0.075$

$(T_b)_B = 100.075$

$(T_b)_A - (T_b)_B = 100.075 = 0.025°C = \left(2.5 \times 10^{-2}\right)$

$x = 100.1,\ y = 2.5$

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1.(29) Vapour measure depends only on temperature

$P_{H_2O} \times V = n_{H_2O}RT$

$V = \frac{0.90}{18} \times \frac{0.082 \times 300}{32} \times 760 = 29.21$

2.(3) $4 = K_b \times 1.5$

$4 = K_f \times 4.5$

$\frac{K_b}{K_f} = \frac{4}{1.5} \times \frac{4.5}{4} = 3$

3.(5) $\Delta T_f = k_f \times \frac{1.2 \times 1.02}{60 \times 2} \times i = 0.0198$

$i = \frac{0.0198 \times 60 \times 2}{1.85 \times 1.2 \times 1.02} = 1.0492 = 1 + \alpha$

$\alpha = 0.0492$

$\%\alpha = 4.92 \approx 5$

4.(330) $\pi = CRT$

$\pi = \frac{W}{M_0 \times V} RT$

$M_0 = \frac{W \times RT}{\pi \times V}$

$M_0 = \frac{2.5 \times 0.083 \times 300 \times 1000}{5.03 \times 10^{-3} \times 500} = 24751.49$

No. of glycine unit = 330

5.(14) $P_{tot} = P_A^\circ \times A + P_B^\circ \times B$

$= 50 \times 0.3 + 100 \times 0.7 = 85$ mmHg

$P_B = P_{tot} Y_B$

$\frac{P_B^\circ \times B}{P_{tot}} = Y_B$

$\frac{100 \times 0.7}{85} = Y_B$

$\Rightarrow Y_B = \frac{70}{85} = \frac{14}{17}$

$\Rightarrow x = 14$

6.(45) $\Delta T_b = K_b \times m$

$373.535 - 373.15 = \frac{.52 \times 2.5}{M.M \times 75 \times 10^{-3}}$

M.M = 45

7.(8) $\Delta T_b = K_b \cdot m$

$$\frac{(\Delta T_b)_1}{(\Delta T_b)_2} = \frac{(K_b)_1}{(K_b)_2}$$

$$\frac{x}{y} = \frac{1}{8}$$

$\Rightarrow y = 8$

8.(98) $\Delta T_f = 2K_f m$

$$0.24 = i \times 1.8 \times \frac{0.5}{7.4 \times 6 \times 0.1}$$

$i = 1.9893 \quad \Rightarrow \quad \alpha = 0.9893 = 98.93 = 99\%$

$\therefore \quad \alpha = 99\% \quad \{i = 1 + (n-1)\alpha\}$

9.(415) $\pi = CRT$

$$\pi = \left[\frac{2 \times 1000}{60 \times 200}\right] \times 0.083 \times 300 = 415 \text{ bar}$$

$\pi = 415 \times 10^5 \text{Pa}$

Integer value is answer

10.(BD) For depression in freezing point

$\Delta T_f = i \times k_f \times$ molality

$$\text{Molality} = \frac{w \times 1000}{Gmm \times W} = \frac{0.7 \times 1000}{93 \times 42}$$

$$.2 = \frac{i \times 1.86 \times .7 \times 1000}{93 \times 42}$$

$i = 0.6$

(i) For dimerization

So $i = 1 - \alpha + \frac{\alpha}{2} = 1 - \frac{\alpha}{2}$

$\alpha = 0.8 = 80\%$

So answer will be D

(ii) For trimerization

$i = 1 - \alpha + \frac{\alpha}{3}$; $i = 1 - \frac{2\alpha}{3} = 0.6$

$\alpha = 0.6 = 60\%$

So answer will be B

11.(54) $\pi = C.R.T$

$7.47 = C \times 0.083 \times 300$

$C = 0.3M$

$= 0.3 \times 180 \, gL^{-1}$

$= 54 \, gL^{-1}$

12.(1222)

Henry's law $P = k_H x$

$0.835 = 1.67 \times 10^3 [x]$

$$x = \frac{1}{2000}$$

As solution is dilute $n_{solute} < n_{solvent}$

$\frac{n_{CO_2}}{n_{H_2O}} = \frac{1}{2000}$; $n_{CO_2} = \frac{n_{H_2O}}{2000}$; $n_{CO_2} = \frac{1000}{2000 \times M_{H_2O}}$

$g_{CO_2} = \frac{1000 \times M_{CO_2}}{2000 \times M_{H_2O}} = 1.2222 = 1222.2 \times 10^{-3}$

Hence the answer should be 1222

13.(1) $P = K_H x$

$= 0.92 = 46.82 \times 10^3 \times x$

$\frac{0.92}{46.82 \times 10^3} = x$ = mole fraction of O_2

$= 0.0196 \times 10^{-3} = \frac{n_{O_2}}{55.5}$

$= 1.09 \times 10^{-3} = n_{O_2}$

= So no. of m moles = $1.09 \times 10^{-3} \times 10^3$

= 1.09

14.(2) According to Rault's law

$P_T = P_A^\circ X_A + P_B^\circ X_B$ (Liquid phase)

According to Dalton's law of partial pressure

$P_T = P_A + P_B$

$Y_A = \frac{P_A}{P_T} = \frac{P_A^\circ X_A}{P_T}$

Given that $Y_A = 0.5$, $X_A = 0.2$, $P_T = 0.8$

$$P_A^\circ = \frac{0.5 \times 0.8}{0.2} = 0.5 \times 4 = 2\,\text{atm}$$

15.(15) 150g CH_3COOH

10.2g ascorbic acid $\Rightarrow$ 0.058 moles

$\Delta T_f = \left(x \times 10^{-1}\right)°C$

$\Delta T_f = k_r$ molality

$= 3.9 \times \frac{0.058}{150} \times 1000$

$= 1.5°C$

$= 15 \times 10^{-1}°C$

16.(3) $\text{RLVP} = \frac{P° - P}{P°} = \frac{n_B}{n_A + n_B}$

For dilute solutions: $\frac{P° - P}{P°} = \frac{n_B}{n_A}$, $n_B << n_A \left[\text{for dilute solution}\right]$

$\frac{P° - P°/2}{P°} = \frac{n_B}{(100/18)} \Rightarrow n_B = 2.7$

Nearest integer is 3.

17.(B) $\Delta T_b = K_b \times m$

$(\Delta T_b)_A = (\Delta T_b)_B$

$m_A = m_B$

Molality (m) $= \dfrac{\%(W/W) \times 1000}{M_A \times W_{solvent}}$

$$\frac{2 \times 1000}{M_A \times 98} = \frac{8 \times 1000}{M_B \times 92}$$

$$M_B = 4M_A$$

18.(1) $\Delta T_b = K_b \times m$

$3 = K_b \times 1$ ...(1)

$\Delta T_f = K_f \times m$

$6 = K_f \times 2$ ....(2)

$(1)/(2) \Rightarrow \dfrac{K_b}{K_f} = \dfrac{1}{1} = \dfrac{1}{X}$

$X = 1$

19.(B) $\dfrac{\Delta T_{fx}}{\Delta T_{fy}} = \dfrac{k_f \cdot m_x}{k_f \cdot m_y} = \dfrac{\frac{1/M_x}{1}}{\frac{1/M_y}{1}}$

$\Rightarrow \dfrac{1}{4} = \dfrac{M_y}{M_x}$ $\Rightarrow M_x : M_y = 1 : 0.25$

20.(C) $[HCOOH] = 0.5\,ml\,l^{-1}$ $\Rightarrow (0.5\,ml \times 1.05\,g\,ml^{-1})$ HCOOH in 1L

$\Rightarrow$ 0.525 g HCOOH in 1L

$m = \dfrac{(0.525/46)}{1kg}$ mol [Assuming dilute solution]

$\therefore \Delta T_f = iK_f m \Rightarrow i = \dfrac{\Delta T_f}{k_f m} = \dfrac{0.0405 \times 46}{1.86 \times 0.525} = 1.9$

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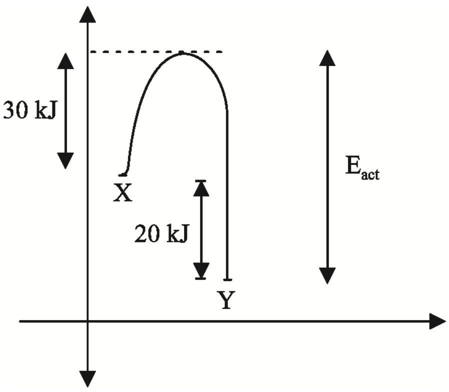
1.(50)



Eact for reverse reaction $= 30 + 20 = 50\,kJ$

2.(14) Fraction of molecules having enough energy to react to form products

$$= e^{-Ea/RT} = e^{-\frac{80.9\times10^3}{8.31\times700}} = e^{-\frac{80900}{5814}} = e^{-13.91} = e^{-14}$$

So, x = 14

3.(52) $\log\frac{k_2}{k_1} = \frac{Ea}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

$$\log 5 = \frac{Ea}{2.303\times8.314}\times\left[\frac{1}{300} - \frac{1}{325}\right]$$

$$.699 = \frac{Ea}{2.303\times8.314}\times\frac{25}{300\times325}$$

$Ea = 52197.02$

$= 52.19\times10^3\,J\,/\,mol$

$E = 52.19\,kJ\,/\,mol$

4.(526) $\log k = \log A - \frac{Ea}{2.303RT}$

Slope $= \frac{-Ea}{2.303R} = -10,000$

$$\log\frac{k_2}{k_1} = \frac{Ea}{2.303R}\times\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log\frac{10^{-4}}{10^{-5}} = 10,000\times\left[\frac{1}{500} - \frac{1}{T}\right]$$

$$\frac{1}{T} = \frac{1}{500} - \frac{1}{10,000}\ ;\quad T = \frac{10,000}{19} \sim 526K.$$

5.(81) $k = \dfrac{0.693}{t_{1/2}} = \dfrac{0.693}{3.33}$

$kt = 2.303 \log \dfrac{A_o}{A_t}$

$\left(\dfrac{0.693}{3.33}\right) \times 9 = 2.303 \log\left(\dfrac{1}{f}\right)$

$\log\left(\dfrac{1}{f}\right) = 0.813$

$= 81 \times 10^{-2}$

6.(108) $C = C_0 e^{-kt}$

For A $\Rightarrow C_A = (C_0)_A\, e^{-K_A t}$

For B $\Rightarrow C_B = (C_0)_B\, e^{-K_B t}$

$\Rightarrow \quad (Co)_A = (Co)_B\,; \qquad \dfrac{C_A}{C_B} = e^{(K_B - K_A)t}\,; \qquad K_A = \dfrac{\ln 2}{(t_{1/2})_A};\; K_B = \dfrac{\ln 2}{(t_{1/2})_B}$

$\Rightarrow \quad 16 = e^{(K_B - K_A)t} \qquad \Rightarrow \quad (K_B - K_A)t = \ln 16 \qquad \Rightarrow \quad \left(\dfrac{\ln 2}{18} - \dfrac{\ln 2}{54}\right)t = \ln 16$

$\Rightarrow \quad \left(\dfrac{\ln 2}{18} - \dfrac{\ln 2}{54}\right)t = 4\ln 2 \qquad \Rightarrow \quad \left(\dfrac{1}{18} - \dfrac{1}{54}\right)t = 4\,; \qquad t = 108\text{ min}$

7.(10) $t_{1/2} = 1\text{ min}$

Assuming reaction to be first order

$K = \dfrac{\ln 2}{t_{1/2}} = \ln 2$

$\ln \dfrac{A_0}{A_t} = Kt$

$\ln \dfrac{A_0}{0.001A_0} = Kt$

$3\ln 10 = \ln 2 \times t$

$t = \dfrac{3 \times 2.3}{0.69} = 10\text{ min}$

8.(2) $k = \dfrac{2.303}{570} \log \dfrac{100}{32}$

$k = \dfrac{2.303}{570} \times 0.49$

$k = 0.002 \quad \text{or} \quad 2 \times 10^{-3}$

9.(10) $\log \dfrac{k_2}{k_1} = \dfrac{Ea}{2.303R}\left[\dfrac{1}{T_1} - \dfrac{1}{T_2}\right]$

$\log \dfrac{1 \times 10^{-3}}{k_1} = \dfrac{11.488 \times 10^3}{2.303 \times 8.314}\left[\dfrac{1}{200} - \dfrac{1}{300}\right]$

$\log \dfrac{1 \times 10^{-3}}{k_1} = \dfrac{11.488 \times 10^3 \times 100}{2.303 \times 8.314 \times 200 \times 300} = \dfrac{6}{6} = 1$

$\log \dfrac{1 \times 10^{-3}}{k_1} = 1$

$$\frac{1\times10^{-3}}{k_1}=10$$

$$k_1=10^{-4}\ s^{-1}=10\times10^{-5}\ s^{-1}$$

10.(27) $\text{rate}=k\left[A\right]^2\left[B_2\right]=k\left(\frac{\text{mole}}{\text{vol.}/3}\right)^2\left(\frac{\text{mole}}{\text{vol.}/3}\right)=k\left[\frac{\text{mole}}{\text{vol.}}\right]^2\left[\frac{\text{mole}}{\text{vol.}}\right]\times3^3=k\left[\frac{\text{mole}}{\text{vol.}}\right]^2\left[\frac{\text{mole}}{\text{vol.}}\right]\times27$

11.(3) $\text{Rate}=k\,[NO]^p\,[Cl_2]^q$

$0.18=k\,[0.10]^p\,[0.10]^q$ ......(1)

$0.35=k\,[0.10]^p\,[0.20]^q$ ......(2)

$1.40=k\,[0.20]^p\,[0.20]^q$ ......(3)

Divide 1 by 2

$$\frac{0.18}{0.35}=\frac{k\,[0.10]^p\,[0.10]^q}{k\,[0.10]^p\,[0.20]^q}$$

$0.51=(0.5)^q$

$q = 1$

Divide 2 by 3

$$\frac{0.35}{1.40}=\frac{k\,[0.10]^p\,[0.20]^q}{k\,[0.20]^p\,[0.20]^q}$$

$0.25=[0.5]^p$

$p = 2$

Overall order $= p + q$

$= 2 + 1 = 3$

12.(A) $R=K[A]^n$

Unit of Rate (R) is mol $L^{-1}\ S^{-1}$

Unit of $[A]^n$ is $mol^n\ L^{-n}$

$\therefore$ Unit of K is $mol^{1-n}\ L^{n-1}\ S^{-1}$

13.(671)

	$1A \rightarrow 2B$	
$t=0$	$n=1$	$-$
$t=\underset{\text{mins}}{100}$	$n=0.9$	0.2

So, according to integrated rate equation for first order reactions.

$$\ell n\left(\frac{A_0}{A_t}\right)=kt$$

$$\ell n\left(\frac{1}{0.9}\right)=k\times100$$

$$k=\frac{\ell n\left(\frac{10}{9}\right)}{100}$$

$$t_{1/2}=\frac{\ell n2}{k}$$

$$t_{1/2}=\frac{0.69\times100}{\ell n\left(\frac{10}{9}\right)}$$

$$t_{1/2}=\frac{69}{\ell n10-\ell n9}$$

$$t_{1/2}=671\text{ minutes}$$

14.(C) Graph (a) is correct for zero order reaction as rate is constant for zero order reaction.

15.(4) $\Delta t=30\ min=0.5\ hr$

$\Delta[B]=0.2\ mol\ L^{-1}$

Average rate of reaction $= +\frac{\Delta[B]}{\Delta t}$

$$= \frac{0.2}{0.5} = 0.4 = 4 \times 10^{-1} \text{ mol L}^{-1} \text{ h}^{-1}$$

16.(7) $N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$

$$K = \frac{1}{t}\ln\frac{a}{a_t}$$

$$= \frac{1}{60} \times \ln\frac{2.4 \times 10^{-2}}{\left(1.6 \times 10^{-2}\right)}$$

$$= \frac{2.303}{60} \times \log\frac{3}{2}$$

$$= 6.75 \times 10^{-3} \text{ min}^{-1}$$

17.(106) Rate of inactivation α amount of virus

$t = 1$ min

$[A_0] = 100$

$[A] = 90$

$$k = \frac{2.303}{1}\log\frac{100}{90}$$

$$k = 2.303\left[1 - 2 \times 0.477\right)$$

$$\boxed{k = 106 \times 10^{-3} \text{ min}^{-1}} \approx 106$$

18.(1) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

t = 0 50 mole/L

t = 120 minutes 10 mole/L

$$K = \frac{2.303}{120}\log\left(\frac{50}{10}\right) \qquad = \frac{2.303}{120} \times 0.6989$$

$$= 0.0134 \qquad = 0.0134$$

$$= 1.3 \times 10^{-2} \qquad = 1 \times 10^{-2}$$

19.(47) $\log k = \log A - \frac{Ea}{2.303RT}$

$$= 20.35 - \frac{2.47 \times 10^3}{T}$$

Hence, $\frac{Ea}{2.303RT} = \frac{2.47 \times 10^3}{T}$

$$Ea = 2.47 \times 10^3 \times 2.303 \times 8.314 \text{ J}$$

$$= 47.293 \times 10^3 \text{ J or } 47 \text{KJ mol}^{-1}$$

20.(2) For 1st order

$$C_0 \xrightarrow[=x]{t_{1/2}} \frac{C_0}{2} \xrightarrow[=x]{t_{1/2}} \frac{C_0}{4}$$

$$\frac{t_{75\%}}{t_{50\%}} = \frac{2x}{x} = 2$$

21.(16) $\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

Now; $E_a = 209 \times 1000$ J / mol

$k_{700} = 6.36 \times 10^{-3} s^{-1}$

$k_{600} = x \times 10^{-6} s^{-1}$

$\log\left(\frac{k_2}{k_1}\right) = \frac{Ea}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

$\log\left(\frac{6.36 \times 10^{-3}}{k_{600}}\right) = \frac{209 \times 10^3}{2.303 \times 8.31}\left[\frac{1}{600} - \frac{1}{700}\right]$

On solving, $\log k_{600} = -4.79$

$k_{600} = 10^{-4.79} = 1.62 \times 10^{-5}$

$k_{600} = 16.2 \times 10^{-6}$

22.(4) According to the question

$\frac{-1}{3}\frac{d[C_2H_6O]}{dt} = \frac{1}{2}\frac{dCr_2(SO_4)_3}{dt}$

Rate of appearance of $Cr_2(SO_4)_3$ is $\frac{d[Cr(SO_4)_3]}{dt}$

Rate of disappearance of C_2H_6O is $\frac{-d[C_2H_6O]}{dt}$

$\frac{-1}{3}\frac{d[C_2H_6O]}{dt} = \frac{1}{2} \times 2.67$

$\frac{-d[C_2H_6O]}{dt} = \frac{3}{2} \times 2.67$

Rate of disappearance of $C_2H_6O = 4.005 \text{ mol min}^{-1}$

23.(1) $7 \times 10^{-9} = K \times (8 \times 10^{-5})^x\ (8 \times 10^{-5})^y$ ……(i)

$2.1 \times 10^{-8} = K \times (24 \times 10^{-5})^x\ (8 \times 10^{-5})^y$ ……(ii)

$= \frac{1}{3} = \left(\frac{1}{3}\right)^x \quad \Rightarrow x = 1$

24.(B) Rate constant (*k*) increases exponentially with temperature (T). option (2) is correct

JEE Advanced 2021

1.(BCD)

	2X	+	Y	$\xrightarrow{k}$ P
t = 0	2 mole		1 mole	
t=50 sec	1 mole		0.5 mole	

$\frac{d[p]}{dt} = -\frac{1}{2}\frac{d(X)}{dt} = k[X]^1$

$2k = \frac{1}{t}\ln\frac{[X]_0}{[X]_t}$

$k = \frac{1}{2 \times 50}\ln\frac{(2/1)}{(1/1)} = \frac{0.693}{100} = 0.00693\ \sec^{-1}$

$$t_{1/2} = \frac{0.693}{2k} = \frac{0.693}{2 \times 6.93 \times 10^{-3}} = 50 \text{ sec}$$

At t = 50 sec $\Rightarrow$ $-\frac{d[X]}{dt} = 2k[X]^1$

$$= 2 \times 6.93 \times 10^{-3} \times \left(\frac{1}{1}\right) = 13.86 \times 10^{-3} \text{ mol lit}^{-1} \text{sec}^{-1}$$

At t = 100 sec $\Rightarrow$ $[X] = 0.5$ M

$$-\frac{d[Y]}{dt} = k[X]^1$$

$$= 6.93 \times 10^{-3} \times 0.5 = 3.465 \times 10^{-3} \text{ mol lit}^{-1} \text{sec}^{-1}$$

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1.(216) $K = Ae^{-Ea/RT}$

$K = (6.5\times10^{-12})e^{-26000\,K/T}$

$\frac{Ea}{RT} = \frac{26000\,K}{T}$

$Ea = (26000\times R = 26000\times 8.314)\,J = 216.16\,kJ = 216\,kJ$

2.(1) $\log\frac{k_{310}}{k_{300}} = \frac{532611}{2\cdot3\times8\cdot3}\left[\frac{10}{310\times300}\right] = 3$

$\frac{k_{310}}{k_{300}} = 10^3 \Rightarrow k_{300} = 10^{-3}\times k_{310} = x\times10^{-3}k_{310}$

$x = 1$

3.(75) $t_{1/2} = 200$ days

$200 = \frac{0.693}{\lambda}$

$\lambda = \frac{0.693}{200}$

$\lambda = \frac{2.303}{t}\log\frac{A_0}{A_t}$

$\frac{0.693}{200} = \frac{2.303}{83days}\log\frac{A_0}{A_t}$

$\log\frac{A_0}{A_t} = 0.125$

$\frac{A_0}{A_t} = \text{Anti}\log(0.125) = 1.333$

% original Activity = $\frac{A_t}{A_0}\times100 = \frac{1}{1.333}\times100 = 75.01\%$

4.(16) $t_{67\%}$ or $t_{2/3} = \frac{2.303}{k}\log\frac{A_0}{A_0-\frac{2}{3}A_0} = \frac{2.303}{k}\log 3$

$t_{50\%}$ or $t_{1/2} = \frac{2.303}{k}\log\frac{A_0}{A_0/2} = \frac{2.303}{k}\log 2$

$\frac{t_{67\%}}{t_{50\%}} = \frac{\log 3}{\log 2} = \frac{0.4771}{0.3} = 1.59 = 15.9\times10^{-1}$

5.(59) $\log\frac{K_2}{K_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1}\frac{-1}{T_2}\right]$

$\log 2 = \frac{E_a}{2.303\times8.314\times10^{-3}}\left[\frac{1}{300}\frac{-1}{309}\right]$

$$\frac{.3010 \times 2.303 \times 8.314 \times 10^{-3} \times 300 \times 309}{9} = E_a$$

$E_a = 59$

6.(166) $\ln K = 33.24 - \frac{2.0 \times 10^4}{T}$

Comparing with $\ln K = \ln A - \frac{E_a}{RT}$

$\Rightarrow \quad \frac{E_a}{R} = 2 \times 10^4$

$\Rightarrow \quad E_a = 2 \times 10^4 \times 8.314 = 166 KJ$

7.(200)

A $\xrightarrow{100}$ A/2 $\xrightarrow{100}$ A/4

B $\xrightarrow{50}$ B/2 $\xrightarrow{50}$ B/4 $\xrightarrow{50}$ B/8 $\xrightarrow{50}$ B/16

Initially A and B are equal.

$t = 200 \sec$

8.(4) $K = A \cdot e^{-\frac{E_a}{RT}}$

$K_{cat} = A \cdot e^{-\frac{E_{a_1}}{RT}}, K_{ac} = A \cdot e^{-\frac{E_{a_2}}{RT}}$

$$\frac{K_{cat}}{K_{ac}} = \frac{e^{-\frac{E_{a_1}}{RT}}}{e^{-\frac{E_{a_2}}{RT}}} = e^{\frac{(E_{a_2} - E_a)}{RT}}$$

$$\frac{K_{cat}}{K_{ac}} = e^{\frac{10 \times 1000}{8.314 \times 300}} = e^4$$

$\frac{K_{cat}}{K_{ac}} = e^4 = e^x \quad \Rightarrow \quad x = 4$

9.(1) $\gamma_1 A + \gamma_2 B \longrightarrow \gamma_3 C + \gamma_4 D$

Given: $+\frac{d(D)}{dt} = \frac{-3}{2} \frac{d[B]}{dt} \quad \Rightarrow \quad \frac{-1}{2} \frac{d[B]}{dt} = \frac{+1}{3} \frac{d[D]}{dt}$

$-\frac{d[B]}{dt} = -2 \frac{d[A]}{dt} \Rightarrow -\frac{1}{2} \frac{d[B]}{dt} = \frac{-d(A)}{dt}$

$+\frac{d[B]}{dt} = 9 \ mmoldm^{-3} s^{-1}$

$\frac{+d[C]}{dt} = \frac{1}{9} \times \frac{+d[D]}{dt}$

$1A + 2B \rightarrow \frac{1}{3}C + 3D \qquad \Rightarrow 3A + 6B \rightarrow C + 9D$

Rate of reaction $= \frac{+d[C]}{dt} = 1\ mmol\ dm^{-3}s^{-1}$

10.(0) $t_{1/2} \propto \frac{1}{A^{n-1}} \propto \frac{1}{P^{n-1}}$

(I) $340 \propto \frac{1}{(55.5)^{n-1}}\left[t_{1/2} \propto \frac{1}{P^{n-1}}\right]$

(II) $170 \propto \frac{1}{(27.8)^{n-1}}$

Dividing $\frac{340 \times \frac{1}{(55.5)^{n-1}}}{170 \propto \frac{1}{(27.8)^{n-1}}} = \frac{340}{170} = \left(\frac{27.8}{55.5}\right)^{n-1} = \left(\frac{1}{2}\right)^{n-1}$

$\Rightarrow 2 = \left(\frac{1}{2}\right)^{n-1} \Rightarrow 2^1 = 2^{1-n} \Rightarrow 1 = 1 - n,\ n = 0$

11.(154) $\ln k = \ln A - \frac{Ea}{10^3 RT} \times 10^3 = \ln A + \frac{10^3}{T}\left[-\frac{Ea}{10^3 RT}\right]$

From the graph

$\frac{-Ea}{10^3 \times RT} = -18.5$

$Ea = 153.735\ kJ / mol$

~ 154

12.(C) $t_{1/2} = \frac{0.693}{K}$

$t_{90} = \frac{2.303}{K}\log\left(\frac{100}{100-90}\right)$

$t_{90} = xt_{1/2}$

$\frac{2.303}{K}\log\frac{100}{10} = x \times \frac{0.693}{K}$

$x = 3.32$

13.(1) $K = \frac{2.303}{t}\log\frac{[R]_o}{[R]_t}$

$\frac{0.6932}{30} = \frac{2.303}{100}\log\frac{[R]_o}{[R]_t}$

$\frac{0.6932 \times 100}{2.303 \times 30} = \log\frac{[R]_o}{[R]_t}$

$1 = \log\frac{[R]_o}{[R]_t}$

$\log 10 = \log\frac{[R]_o}{[R]_t}$

$[R]_t = \frac{1}{10} = 0.1 = 1 \times 10^{-1}\mu g$

14.(40) $R = K[X]^1[Y]^0$

$2\times10^{-3} = K[0.1]$

$2\times10^{-2} = K$

$4\times10^{-3} = 2\times10^{-2}[L]$

2×10^{-1} $\quad 2\times10^{-1} = L \quad \frac{8}{0.2} = 40$

$M\times10^{-3} = 2\times10^{-2}\times0.4$

$M\times10^{-3} = 8\times10^{-3}$

= 40

15.(8) As $\ell n\,K = \ell n\,A - \frac{E_A}{R}\left(\frac{1}{T}\right)$

Magnitude of the slope $= \frac{E_A}{R} = \frac{20}{5} = 4$

$\therefore \quad E_A = 4(R) = 8 \text{ cal mol}^{-1}$

16.(100) $A \rightarrow B \qquad t_{1/2} = 0.3010 \text{ min}$

A_0 / A_t at time 2 min = ?

$K = \frac{2.303}{t}\log\left[\frac{A_0}{A_1}\right]$

$\Rightarrow \quad \frac{0.693}{t_{\frac{1}{2}}} = \frac{2.303}{2}\log\left(\frac{A_0}{A_t}\right)$

Or $\frac{2.303\times0.3010}{0.3010} = \frac{2.303}{2}\log\frac{A_0}{A_t}$

$\therefore \quad \frac{A_0}{A_t} = 10^2 = 100$

17.(A) The is recorded immediately after the blue colour appears.

$Na_2S_2O_3$ is kept in limited amount.

18.(165) $t_{1/2} = \frac{0.693}{k}$ (for 1st order reaction)

$k = \frac{0.693}{70\times60} = 165\times10^{-6}s^{-1}$

19.(2) $\gamma = k[NO]^x\,[H_2]^y$

$\Rightarrow \quad 0.135 = k\,(40)^x\,(65.6)^y \qquad \dots (1)$

$\Rightarrow \quad 0.033 = k\,(20.1)^x\,(65.6)^y \qquad \dots (2)$

$\Rightarrow \quad 0.214 = k\,(65.6)^x\,(38.6)^y \qquad \dots (3)$

Dividing equation (1) by (2)

$\frac{0.135}{0.033} = \left(\frac{40}{20.1}\right)^x$

$\Rightarrow \quad 4.09 = (1.99)^x \quad \Rightarrow \quad x \approx 2$

20.(C) $t_{1/2}$ is independent of initial concentration, it means reaction is of first order.

For Ist order reaction, $t_{1/2} = \frac{0.693}{k}$

$$k = \frac{0.693}{200}$$

Also for Ist order reaction

$$t = \frac{2.303}{k}\log_{10}\left(\frac{a}{a-x}\right)$$

$$t = \frac{2.303\times 200}{0.693}\times\log_{10}\left(\frac{100}{100-80}\right)$$

$$t = \frac{2.303\times 200}{0.693}\times\log_{10}\left(\frac{100}{20}\right)$$

$$t = \frac{2.303\times 200}{0.693}\times 0.7 \ \ [\log_{10}(5) = 0.695 \simeq 0.7]$$

$$t = 466.25 \text{ sec} \simeq 467 \text{ sec}$$

21.(2) $A \longrightarrow 2B + C$

$$t_{1/2} \propto \frac{1}{[A_0]^{n-1}}$$

$$\frac{(t_{1/2})_1}{t_{(1/2)_2}} = \left(\frac{[A_0]_2}{[A_0]_1}\right)^{(n-1)}$$

$$\frac{100}{50} = \left(\frac{10}{0.5}\right)^{n-1}$$

$$(2)' = (2)^{n-1}$$

$$n-1 = 1 \Rightarrow n = +1+1 = 2$$

22.(2) For first order reaction

$$k = \frac{1}{t}\ln\left(\frac{P_0}{P}\right)$$

$$\ln\left(\frac{P_0}{P}\right) = kt$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{3.465\times 10^4} = 2\times 10^{-5}$$

23.(1) $(t_{1/2})_{500\,\text{torr}} = 240\,\text{sec} = 4\,\text{min}$

$(t_{1/2})_{250\,\text{torr}} = 4\,\text{min}$

$t_{1/2} \propto a^{1-n}$

As $t_{1/2}$ is independent of initial pressure. Hence, order is 1^{st} order.

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Electrochemistry	Class - XII | Chemistry

JEE Main 2021

1.(25) $\underset{1\,\text{mole}}{MnO_4^-} + 8H^+ + \underset{5\,\text{Faraday}}{5e^-} \longrightarrow Mn^{2+} + 4H_2O \quad E^0 = 1.51$

No. of Faraday to reduce 1 mole $MnO_4^- = 5$

No. of Faraday to reduce 5 mole $MnO_4^- = 5 \times 5 = 25F$

2.(147) $E^\circ_{cell} = E^\circ_{Zn/Zn^{+2}} + E^\circ_{Ag^{\oplus}/Ag}$

= 0.76 + 0.80 = 1.56 V

Cell reaction is $Zn(s) + 2Ag^{\oplus}(aq) \longrightarrow Zn^{+2}(aq) + 2Ag(s)$

Cells $= E^\circ_{cell} - \frac{0.059}{2}\log\frac{[Zn^{+2}]}{[Ag^+]^2} = 1.56 - \frac{0.059}{2}\log\frac{10^{-1}}{(10^{-2})^2}$

$= 1.56 - \frac{0.059}{2}\log\ 10^{+3} = 1.56 - \frac{0.059}{2} \times 3 = 1.56 - 0.0885$

$= 1.4715\ V = 147 \times 10^{-2}\ V$

So, x = 147

3.(1) Bonus

Data insufficient

4.(3776) $5e^- + 8H^+ + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O$

$E_{cell} = E^\circ - \frac{0.059}{5}\log\frac{[Mn^{2+}]}{[MnO_4^-][H^+]^8}$

when $[H^+] = 1M$

$E_1 = E^\circ - \frac{0.059}{5}\log\ 1$

$= E^\circ$

when $[H^+] = 10^{-4}\,M$

$E_2 = E^\circ - \frac{0.059}{5}\log\frac{1}{\left(10^{-4}\right)^8}$

$= E^\circ - \frac{0.059}{5} \times 32$

$E_1 - E_2 = 0.3776V$

$= 3776 \times 10^{-4}$

$x = 3776$

5.(14) $\wedge_m = \frac{1000K}{M}$

$k = C\left(l/a\right) = 0.55 \times 10^{-3} \times 1.3 = 0.715 \times 10^{-3}\ Scm^{-1}$

$M = 5 \times 10^{-3}\ M$

$\wedge_m = \dfrac{1000 \times 0.715 \times 10^{-3}}{5 \times 10^{-3}} = 143\ S\,cm^2\ mol^{-1}$

$= 14.3 \times 10^{-4} \times 10^3\ m\,S\ m^2\ mol^{-1} = 14.3\ m\,S\ m^2\ mol^{-1}$

6.(288) $\lambda^0_{BaCl_2} = 280\ S\,cm^2\ mol^{-1}$

$\lambda^0_{H_2SO_4} = 860\ S\,cm^2\ mol^{-1}$

$\lambda^0_{HCl} = 426\ S\,cm^2\ mol^{-1}$

$\lambda^0_{BaSO_4} = ?$

Using KOHLRAUSH'S LAW of independent migration of ions

$\lambda^0_{BaSO_4} = \lambda^0_{BaCl_2} + \lambda^0_{H_2SO_4} - 2\lambda^0_{HCl}$

$\lambda^0_{BaSO_4} = 280 + 860 - (2 \times 426) = 288$

7.(A) Conductivity of ions α Ionic mobility, Ionic Mobility $\alpha \dfrac{1}{\text{ionic Radius}}$

In aqueous solution, size of Cs^+ is smallest. So the order of conductivity is $Cs^+ > Rb^+ > K^+ > Na^+$

8.(57) $R = \rho\left(\dfrac{\ell}{A}\right)$

$4.19 = \dfrac{1}{0.14} \times \dfrac{\ell}{A}$ ...(i)

$1.03 = \dfrac{1}{K} \times \dfrac{\ell}{A}$ ...(ii)

$\dfrac{4.19}{1.03} = \dfrac{K}{0.14}$

$K = 0.57 = 57 \times 10^{-2}\ Sm^{-1}$

9.(45) $Fe^{+3} + 3e^- \longrightarrow Fe \qquad E^o_1 = -0.036$

$Fe^{+2} + 2e^- \longrightarrow Fe \qquad E^o_2 = -0.440$

$Fe^{+3} + e^- \longrightarrow Fe^{+2} \qquad E^o_3 = ?$

$\Delta G^o_3 = \Delta G^o_1 - \Delta G^o_2$

$-1 \times F \times E^o_3 = -3 \times F \times (-0.036) - [-2 \times F \times (-0.440)]$

$E^o_3 = 0.772\,V$

$E^o_{cell} = E^o_{Fe^{+3}/Fe^{+2}} + E^o_{I^-/I_2} = 0.772 + (-0.539) = 0.233$

$\Delta G^o = -nFE^o_{cell} = -2 \times 96.5 \times 0.233 = -44.9 = -45\ kJ$

10.(12) $(\wedge_m)_{HA} = \dfrac{1000K}{C} = 20$

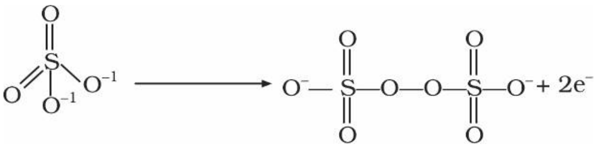
$\alpha = \dfrac{\wedge_m}{\wedge^o_n} \Rightarrow \alpha = \dfrac{2}{19}$

$HA \rightleftharpoons H^+ + A^-$

$C - c\alpha \qquad c\alpha \qquad c\alpha$

$$K_a = \frac{c\alpha}{(1-\alpha)} \quad \Rightarrow \quad K_a = 12 \times 10^{-6}$$

11.(D) In electrolytic oxidation of acidified sulphate solution, sulphate ion undergoes oxidation as



$$S_2O_8^{2-} + \underset{\substack{\downarrow \\ \text{From acidic medium}}}{2H^+} \longrightarrow \underset{\text{Peroxydisulphuric acid}}{HO_3SOOSO_3H}$$

12.(28) $Cu + 2Ag^+ \rightleftharpoons Cu^{+2} + 2\ Ag$

$$Q_c = \frac{[Cu^{+2}]}{[Ag^{+1}]^2}$$

For $[Cu^{+2}] = 0.1\text{ M}, [Ag^+] = 0.01\text{ M}$

$$E_{cell} = E^o_{cell} = -\frac{0.059}{2}\log\frac{Cu^{+2}}{(Ag^+)^2}$$

$$0.3095 = E^o_{cell} - \frac{0.059}{2}\log_{10}\frac{10^{-1}}{10^{-4}}$$

$$0.3095 = E^o_{cell} - 1.5\ [0.059]$$

$$\therefore\ E^o_{cell} = 0.3095 + 1.5[0.059]$$

For $[Cu^{+2}] = 0.01,\ [Ag^+] = 10^{-3}\text{ M}$

$$E_{cell} = 0.3095 + 1.5[0.059] - \frac{0.059}{2}\log\frac{10^{-2}}{\log^{-6}} \qquad = 0.3059 + 1.5[0.059] - 2[0.059]$$

$$= 0.3095 - \frac{0.059}{2} \qquad = \left[30.95 - \frac{5.9}{2}\right] \times 10^{-2}$$

$$= 28 \times 10^{-2}$$

13.(24) $E_{cell} = E^\circ_{cell} - \dfrac{0.06}{n}\log Q$

$$A - Zn(s) \rightleftharpoons Zn^{+2}{}_{(aq)} + 2e^-$$

$$C - 2Fe^{+3}{}_{(aq)} + 2e^- \rightleftharpoons 2Fe^{+2}{}_{(aq)}$$

$$Zn_{(s)} + 2Fe^{+3}{}_{(aq)} \rightleftharpoons 2Fe^{+2}_{(aq)} + Zn^{+2}_{(aq)}$$

(1 M)

$$E^\circ_{cell} = E^\circ_{RP(cathode)} - E^\circ_{RP(anode)} = 0.77 - (-0.76) = 1.53\text{V}$$

$$1.5 = 1.53 - \frac{0.06}{2}\log\frac{\left[Zn^{+2}\right]\left[Fe^{+2}\right]^2}{\left[Fe^{+3}\right]^2}$$

$$\frac{0.03}{0.06} = \log\frac{\left[Fe^{+2}\right]}{\left[Fe^{+3}\right]}$$

$$\frac{\left[Fe^{+2}\right]}{\left[Fe^{+3}\right]} = \sqrt{10} \approx 3.16$$

$$\frac{\left[Fe^{+3}\right]}{\left[Fe^{+3}\right]+\left[Fe^{+2}\right]} = \frac{\left[Fe^{+3}\right]}{\left[Fe^{+3}\right]+3.16\left[Fe^{+3}\right]} = 0.24$$

14.(3) $E_{cell} = E^0_{cell} - \frac{0.0591}{2}\log\frac{0.250}{\left(0^{-3}\right)^2}$

$= 2.97 - \frac{0.0591}{2}\log 2.5\times 10^5 = 2.83 = 3$

15.(1) 122.6 gm is deposited by passing $6\times 96500C$ charge

10 gm potassium chlorate is deposited on passing charge = $\frac{6\times 96500}{122.6}\times 10C$

Hence charge = current × time

Current = $\frac{6\times 96500\times 10}{122.6\times 10\times 60\times 60} = 1.3 \approx 1$

16.(26) Cell constant = Rk = 0.243 × 1.07 × 10^6 = 24.3 ×1.07 ×10^4 m^{-1}

Ans $\Rightarrow$ 26

17.(D) (a) Cell constant = $\frac{l}{a} = \frac{m}{m^2} = m^{-1}$

(b) Molar conductivity = $\frac{k}{m} = Scm^2mol^{-1}$

(c) Conductivity = $\frac{l}{e} = ohm^{-1}m^{-1}$

(d) degree of dissociation = Dimensionless.

18.(25) $\Delta G° = -nFE°$

$= -(2)(96487)(4.315)$

$= -832682$

$\Delta G° = \Delta H° - T\Delta S°$

$-832682 = -825200 - (298)(\Delta S°)$

$\Delta S° = 25\ JK^{-1}$

19.(760) $R = \rho\left(\frac{l}{A}\right)$ or $\frac{1}{\rho} = \frac{1}{R}\left(\frac{l}{A}\right)$ or $k = GG*$

$k = \frac{1}{R}\left(\frac{l}{A}\right) \Rightarrow k = \frac{1}{1500}\times 1.14\ Scm^{-1}$

$\wedge_m = \frac{k}{c}\times 1000 = \left(\frac{1.14}{1500}\right)\times\frac{1}{10^{-3}}\times 10^3 = 760\ Scm^2\ mol^{-1}$

20.(109) $Zn + Cu^{2+} \rightleftharpoons Zn^{2+} + Cu$

0.02 M   0.04 M

$E°_{cell} = E°_{Cu^{2+}/Cu} - E°_{Zn^{2+}/Zu}$

$= 0.34 - (-0.76)$

$E°_{cell} = 1.1\ V$

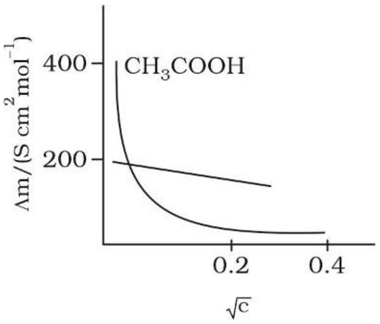
$E_{cell} = E°_{cell} - \frac{2.303RT}{nF}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

$= 1.1 - \frac{0.059}{2}\log\frac{0.04}{0.02} = 1.1 - \frac{0.059}{2}\log 2$

$= 1.1 - \frac{0.059}{2} \times 0.3010$

$E_{cell} = 1.09 = 109 \times 10^{-2}\,V$

21.(B)



Limiting molar conductance of CH_3COOH is greater than that of KCl due to high conducting H^+ ions.

On decreasing the concentration, molar conductance increases.

JEE Advanced 2021

1.(ABC) X is anode

$X + Y^{2+} \rightleftharpoons X^{2+} + Y$ (Cell reaction)

$E_{cell} = E^\circ_{cell} - \frac{0.059}{2}\log_{10}\frac{[X^{2+}]}{[Y^{2+}]}$

$= E^\circ_{cell} - \frac{0.059}{2}\log_{10}\frac{10^{-3}}{10^{-1}} = E^\circ_{cell} + 0.059$

If X = Cd, Y = Ni

$E_{cell} = 0.16 + 0.059 = 0.219\ V$

If X = Cd, Y = Fe

$E_{cell} = -0.04 + 0.059 = 0.019\ V$

If X = Ni, Y = Pb

$E_{cell} = 0.11 + 0.059 = 0.169\ V$

If X = Ni, Y = Fe

$E_{cell} = -0.2 + 0.059 = -0.141\ V$

2.(0.22) 3.(0.86)

$(\lambda_m^\infty)_{HA} = 4 \times 10^{+2}\ S - cm^2 - mol^{-1}$

$\alpha = \frac{\lambda_m^c}{\lambda_m^\infty} = \frac{Y \times 10^{+2}}{4 \times 10^{+2}} = \frac{Y}{4}$

Upon 20 times dilution with water

$(\lambda_m^c)_{new} = 3(\lambda_m^c)_{old}$

$\Rightarrow \quad \alpha_{new} = 3 \times \alpha_{old}$

$K_a = \frac{C\alpha^2}{1-\alpha} = \left(\frac{C}{20}\right)\frac{(3\alpha)^2}{(1-3\alpha)}$

$20(1-3\alpha) = 9 - 9\alpha$

$20 - 60\alpha = 9 - 9\alpha$

$51\alpha = 11$

$\Rightarrow \quad \alpha = 0.215 \simeq 0.22$

$Y = 4\alpha = 0.215 \times 4 = 0.86$

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1.(7) Cell reaction is

$$H_2(g) + Cu^{2+}(aq) \longrightarrow Cu(s) + 2H^+(aq)$$

1 bar M – 10^{-3}M

$$0.31 = 0.34 - \frac{0.06}{2}\log\frac{(10^{-3})^2}{x}$$

$$\frac{(0.31-0.34)\times 2}{0.06} = \log\frac{10^{-6}}{x}$$

$$\frac{10^{-6}}{x} = 10 \quad \Rightarrow \quad x = 10^{-7} = 10^{-x}$$

2.(127) $2H_2O(\ell)\xrightarrow{4F} 2H_2 + O_2$

$$\text{No. of F} = \frac{I\times t}{96500} = \frac{0.10\times 2\times 60\times 60}{96500}$$

$$\text{No. of mole of } H_2 = \frac{1}{2}\times \text{No. of F} = \frac{1}{2}\times\frac{0.10\times 2\times 60\times 60}{96500}$$

$$\text{No. of mole of } O_2 = \frac{1}{4}\times \text{No. of F} = \frac{1}{4}\times\frac{0.10\times 2\times 60\times 60}{96500}$$

$$\text{Vol. of } H_2 = \frac{1}{2}\times\frac{0.10\times 2\times 60\times 60}{96500}\times 22.7 = 0.08468$$

$$\text{Vol. of } O_2 = \frac{1}{4}\times\frac{0.10\times 2\times 60\times 60}{96500}\times 22.7 = 0.04234$$

Total volume = 0.12702L = 127cm^3

3.(16) $S_n^{4+} + 4e^{(-)} \to Sn \quad \Delta G_1^0 = -4\times 0.010F$

$$\underline{Sn^{2+} \pm 2e^{(-)} \to Sn \ \Delta G_2^0 = -2\times(-0.140)F}$$

$$Sn^{4+} + 2e^{(-)} \to Sn^{2+}\Delta G_3^0 = (-0.04 - 0.28)F$$

$$\Delta G_3^0 = -0.32F$$

$$Sn^{4+} + 4e^{(-)} \to Sn \ \Delta G_1^0 = -4\times 0.010F$$

$$\underline{\_Sn^{2+} \pm 2e^{(-)} \to Sn \ \Delta G_2^0 = -2\times(-0.140)F}$$

$$Sn^{4+} + 2e^{(-)} \to Sn^{2+}\Delta G_3^0 = -0.32F$$

$$\Delta G_3^0 = -nE^0F$$

$$-0.32F = -2\times E^0\times F$$

$$E^0 = \frac{-0.32}{-2} = 0.16eV \quad = 16\times 10^{-2}eV$$

4.(3) $\wedge_m^\infty = \dfrac{k}{1000s}$

$A_2X_3 \rightleftharpoons \underset{2s}{2A^{3+}} + \underset{3s}{3X^{2-}}$ where s is solubility.

$k_{sp} = (2s)^2(3s)^3 = 108 \times s^5$

$108s^5 = 1.1 \times 10^{-23} = 110 \times 10^{-25}$

$s = \left(\dfrac{110 \times 10^{-25}}{108}\right)^{1/5} \Rightarrow s = 10^{-5}$

$\wedge_m^\infty = \dfrac{3 \times 10^{-5}}{1000 \times 10^{-5}} = 3 \times 10^{-3}$

5.(6) $6e^- + Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$

$\therefore$ 6 F is needed to reduce 1 mol of $Cr_2O_7^{2-}$ to Cr^{3+}

6.(51) $\Delta G^0 = -nFE^0_{cell} = 1 \times 96500 \times 0.5332 \text{ kJmol}^{-1} = 51453.8 \text{ kJmol}^{-1} = 51 \text{ kJmol}^{-1}$

7.(C) Copper has positive Cu^{+2} / Cu

Electrode potential (+ 0.34)

8.(14) $\lambda^0_{AgI} = \lambda^0_{NaI} + \lambda^0_{AgNO_3} - \lambda^0_{NaNO_3}$

$= 12.7 + 13.3 - 12.0$

$= 14$

9.(C)

10.(983) $E^\circ_{cell} = E^\circ_{Sn^{+2}/Sn} - E^\circ_{Cu^{+2}/Cu} = -0.14 - 0.34 = -0.48$ V

$E_{cell} = E^\circ_{cell} - \dfrac{0.0591}{n}\log\dfrac{[Cu^{+2}]}{[Sn^{+2}]} = -0.48 - \dfrac{0.059}{2}\log\dfrac{10^{-2}}{10^{-3}} = -0.48 - \dfrac{0.059}{2}\log 10$

$E_{cell} = -0.48 - \dfrac{0.059}{2} = -0.5 \text{ V} \quad \Rightarrow \quad -0.51$

$\Delta G = -nF\,E_{cell} = -2 \times 96500 \times (-0.51) = 9833$

$\Delta G = 9833 \text{ kJ / mol} = 983.3 \times 10^{-1} \text{kJ/mol} \quad \Rightarrow \quad X = 983$

11.(23) The cell reaction is

$2Fe^{3+} + 2I^{\ominus} \longrightarrow 2Fe^{2+} + I_2$

$E^0_{cell} = E^0_R - E^0_L$

$= 0.77 - 0.54 = 0.23V = 23 \times 10^{-2} V \simeq x \times 10^{-2} V$

So $x = 23$

12.(20) $3 \times 96500C$ deposits 56 gm of Fe

Q_C deposits 0.3482 g of Fe

$Q_C = \dfrac{3 \times 96500a0.3482}{56} = \dfrac{1.5 \times t}{60}$

$t = 20 \text{ min}$

13.(A) As per standard potential values

$E^0_{Cl_2/Cl^-} = +1.36, \; E^0_{Ag^+/Ag} = +0.80, \; E^0_{I_2/I^-} = +0.54v$

$E^0_{Na^+/Na} = -2.71 \quad E^0_{Li^+/Li} = -3.05$

$\Rightarrow$ order of reduction potentials : A > C > B > D > E

14.(5) Anode : $H_2 \to 2H^+ + 2e^-$

Cathode : $Cu^{2+} + 2e^- \to Cu$

$Cu^{2+} + H_2 \to 2H^+ + Cu$

$$E_{cell} = E^0_{cell} - \frac{0.06}{2}\log\frac{[H^+]^2}{[Cu^{2+}]}$$

$$0.576 = 0.34 - \frac{0.06}{2}\log\left\{\frac{[H^+]^2}{(0.01)}\right\}$$

$+3.93 - \log[H^+] + \log 0.1 \Rightarrow pH = 4.93 \simeq 5$

15.(266) $K = \frac{1}{R} \times \text{cell constant}$

$$0.152 \times 10^{-3} = \frac{1}{1750} \times \text{cell constant}$$

Cell constant $= 266 \times 10^{-3}$

16.(34) $E_{cell} = E^0_{cell} - \frac{0.06}{n}\log\frac{\left[Cu^{2+}\right]}{\left[Ag^+\right]^2}$

$$0.43 = E^0_{cell} - \frac{0.06}{2}\log\frac{\left[0.001\right]}{\left[0.01\right]^2}$$

$$0.43 = E^0_{cell} - \frac{0.06}{2}\log 10^1$$

$0.43 + 0.3 = E^0_{cell}$

$E^0_{cell} = E^0_{cathride} - E^0_{anode}$

$0.46 = 0.80 - E^0_{anode}$

$0.34 = E^0_{anode}$

$34 \times 10^{-2}\,V = E^0_{anode}$

17.(1000) As given $R_1 = 100\,\Omega$, $R_2 = 50\,\Omega$

To calculate $\frac{\wedge_1}{\wedge_2} = x \times 10^{-3}$

$G^* = 129\,m^{-1}$

$C_1 = 74.5\,ppm \quad C_2 = 149\,ppm$

$R_1 \times K = G^*$

$100 \times K = 129\,m^{-1}$

$K_1 = \frac{129}{100} = 1.29 \qquad K_2 = \frac{129}{50}$

$$\frac{\wedge_1}{\wedge_2} = \frac{1.29 \times 1000}{74.5}$$

$$\frac{\wedge_1}{\wedge_2} = \frac{\frac{1.29 \times 1000}{74.5}}{\frac{129 \times 1000}{50 \times 149}} = 1$$

So, 1000×10^{-3}

18.(A) Copper is least electropositive among the given metals and it lies below H in reactivity series

19.(C) (a) $Cd(s) + 2Ni(OH)_3(s) \Rightarrow CdO(s) + 2Ni(OH)_2(s) + H_2O(l)$

Discharge of secondary Battery

(b) $Zn(Hg) + HgO(s) \rightarrow ZnO(s) + Hg(l)$

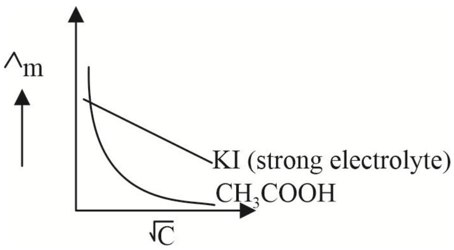
Primary Battery Mercury cell

(c) $2PbSO_4(s) + 2H_2O(l) \rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4(aq)$

Charging of secondary Battery

(d) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l) -$ Fuel cell

20.(B)



21.(3) $2e^{(-)} + 6e^{(-)} = 8e^{(-)}$

for of 1 mole Fe = $\frac{8}{3} = 2.66 = 3$

$Fe_3O_4 \longrightarrow 3Fe$

$FeO + 2e^{(-)} \longrightarrow Fe$

$Fe_2O_3 + 6e^{(-)} \longrightarrow 2Fe$

Total $e^{(-)} = 8e^{(-)}$

For 1 mole $Fe = \frac{8}{3} = 2.66 = 3$

22.(A) $\wedge_m = \kappa \times \frac{1000}{M}$

$\Rightarrow \wedge_m \propto \frac{1}{M}$

$\frac{\wedge_{m_1}}{\wedge_{m_2}} = \frac{M_2}{M_1} = \frac{\frac{20}{80}}{\frac{10}{20}} = \frac{1}{4} \times \frac{2}{1} = \frac{1}{2}$

$\Rightarrow \wedge_{m_2} = 2\wedge_{m_1}$

23.(4) $E = E^0 - \frac{2.303\,RT}{nF}\log Q$

Here, $E = +0.801V, E^0 = 0.008 - (-0.763) = +0.771V$

$\therefore 0.801 = +0.771 - \frac{0.06}{n}\log 10^{-2}$

$\Rightarrow n = 4$

JEE Advanced 2022

1.(0.77)

$MnO_4^-(aq) + 4H^+ + 3e^- \longrightarrow MnO_2 + 2H_2O$ $E^\circ = 1.68\,V$ **...... (1)**

$MnO_2(s) + 4H^+ + 2e^- \longrightarrow Mn^{2+}(aq) + 2H_2O$ $E^\circ = 1.21\,V$ **...... (2)**

$Mn^{2+}(aq) + 2e^- \longrightarrow Mn(s)$ $E^\circ = -1.03\,V$ **...... (3)**

Equation = Eqs. (1) + (2) + (3)

$MnO_4^-(aq) + 8H^+ + 7e^- \longrightarrow Mn(s) + 4H_2O \qquad E^\circ = ?$

$\Delta G^\circ = \Delta G_1^\circ + \Delta G_2^\circ + \Delta G_3^\circ$

$\Rightarrow \qquad -7 \times E^\circ \times F = -3(1.68)F - 2(1.21)F - 2(-1.03)F$

$\Rightarrow \qquad -7 \times E^\circ = -5.04 - 2.42 + 2.06$

$\Rightarrow \qquad E^\circ = \dfrac{-5.4}{-7} = 0.7714 = 0.77\ V$

Solutions of Archive - JEE Main & Advanced

Surface Chemistry	Class - XII | Chemistry

JEE Main 2021

1.(D) If $FeCl_3$ is added to excess of hot water, a positively charged sol of hydrated ferric oxide is formed due to adsorption of Fe^{+3} ions.

2.(2) PV = nRT

$$V = \frac{nRT}{P} = \left(\frac{3.12}{32}\right) \times \frac{0.0821 \times 300}{1} = 2.4L$$

Volume of O_2 adsorbed by 1.2 g of adsorbent $= 2.4L$

Volume of O_2 adsorbed by 1g of adsorbent $= \frac{2.4}{1.2} = 2L$

3.(C) The viscosity of hydrophilic sols is higher than that of H_2O.

4.(D) $\frac{x}{m} \alpha p^{1/n}, \frac{x}{m} = k \times p^{1/n}$; $\log\frac{x}{m} = \log k + \frac{1}{n}\log p$

5.(D) Blood is negative sol. The cation with high charge has high coagulation power

$\therefore$ $FeCl_3$ can be used for clotting blood.

6.(D) $\frac{x}{m} = K\ P^{1/n}$

$$\underbrace{\log\frac{x}{m}}_{y} = \underbrace{\log K}_{c} + \underbrace{\frac{1}{n}}_{m}\underbrace{\log P}_{x}$$

Slope $= \frac{1}{n}$ (where $1/n$ is 0 to 1)

7.(B) Colloidal particles passes through ordinary filter paper.

Flocculating power - $Al^{+3} > Na^{+}$ (Higher charge)

Colloidal solution shows Bromnian motion of colloidal particles.

8.(C) Sulphide colloidal sols are negatively charged while hydroxide and oxide sols are positively charged.

9.(B) Gas dispersed in a solid is called solid sol.

10.(A) For a negative sol, positive ion is required for flocculation. Greater the valency of the flocculating ion added, the greater is its power to cause precipitation. This is called Hardy-Schulze law.

So, Ba^{2+} has highest flocculating power.

11.(17) $\frac{x}{m} \propto (P)^{1/n}$

If pressure is doubled & $\frac{x}{m}$ becomes 64 times.

$\therefore$ $n = \frac{1}{6} = 0.167$

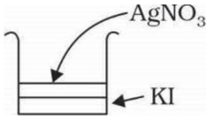
12.(C) Gases with higher critical temperature can be adsorbed at greater extent. Due to stronger nature of V.W. interactions in $SO_2(g)$ as compared to $H_2(g)$, its critical temperature is higher than that of $H_2(g)$.

13.(A) Sodium stearate is an anionic surfactant. It forms spherical micelles with $CH_3(CH_2)_{16}-$ group pointing towards the centre of sphere.

14.(D)

	Examples of colloids		**Classification**
(a)	Cheese	(iv)	Dispersion of liquid in solid
(b)	Pumice stone	(iii)	Dispersion of gas in solid
(c)	Hair cream	(i)	Dispersion of liquid in liquid
(d)	Cloud	(ii)	Dispersion of liquid in gas

15.(D)



Sol = AgI / I^-

16.(D) The conditions (a) and (e) are in the content of observing Tyndall effect in colloidal solutions.

17.(1) moles of $Cl^- = \frac{0.0018}{35.5 \times 100} \times 1000 = \frac{0.018}{35.5}$

in 1 litre

Mill moles of $Cl^- = \frac{0.018}{35.5} \times 1000 = 0.507 = 1$

In 1 litre

18.(D) (i) Au (sol.) is prepared by reduction of $AuCl_3$ using HCHO

(ii) As_2S_3 (sol.) is prepared by double displacement reaction between As_2O_3 and H_2S

(iii) S(sol) is prepared by oxidation of H_2S by SO_2 overall it is a comproportiation redox reaction

(iv) $Fe(OH)_3$ (sol.) is prepared by hydrolysis of $FeCl_3$

19.(128) According to Freundlich adsorption isotherm, $\frac{x}{m} = kp^{1/n}$

m = 1 gm for charcoal

$x \propto$ volume of CH_4 adsorbed

So, $10 \propto k(100)^{1/n}$ ...(i)

$15 \propto k(200)^{1/n}$ ...(ii)

From equation (i) and (ii)

$\frac{3}{2} = (2)^{1/n}$

$\log\left(\frac{3}{2}\right) = \frac{1}{n}\log 2$

So, $\frac{1}{n} = 0.585$

$10 = k \times (100)^{1/n}$

$k = \frac{10}{(100)^{0.585}} = 0.6760$

For P = 300 mm Hg

$V = 0.6760 \times (300)^{0.585} = 19$ Appox.

$10^x = 19$

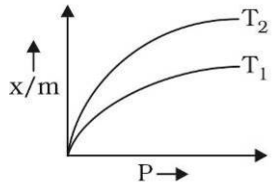
$x = \log 19 = 1.279 \approx 1.28$

Ans. 128×10^{-2}

20.(A) As per Freundlich adsorption isotherm

$\frac{x}{m} = K\ p^{1/n}$

At fixed pressure there is a decrease in physical adsorption with increase in temperature



$T_1 > T_2$

21.(B) Lyophilic sols are extensively solvated due to their affinity for the dispersion medium, which makes them stable.

22.(D) Tyndall effect is effectively shown by lyophobic colloidal solution.

23.(A) $AgNO_3$ added to KI solution forms AgI and it will adsorb I^- ions.

Thus forms negatively charged sol.

24.(C) Adsorption of gas is exothermic process $\Rightarrow$ $\Delta H = -ve$

Rondomness decreases $\Rightarrow$ $\Delta S = -ve$

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1.(BC) The process of converting ppt into colloid is peptization.

Micelles are Associated colloids.

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1.(D) The minimum concentration of an electrolyte in millimoles per litre required to cause precipitation of a sol in two hours is called coagulating value.

42.12 gm in 100 mL

(42.12×10) gm in 1L

$\frac{42.12\times10}{58.5}$ mole in 1L

$\frac{42.12\times10}{58.5}\times1000$ m mole / L (in 10 hrs.)

$\frac{42.12\times10\times1000}{58.5}\times\frac{2}{10}$ m mole / L $\Rightarrow$ 1440 m mol L^{-1}

2.(D) The presence of equal and similar charges on colloidal particles is largely responsible in providing stability to the colloidal solution.

3.(C) Fact

4.(C) Zeta potential is related to the charge on the surface of colloidal particles.

5.(12) Freundlich adsorption isotherm equation

$\frac{x}{m}\propto P^{1/n}$

$\frac{x}{m}=kP^{1/n}$

$\log\frac{x}{m}=\log k+\frac{1}{n}\log P$

$\log\frac{x}{m}=.602+1\times\log .03$

$\log\frac{x}{m}=.602+\log 3\times10^{-2}=.602+\left[\bar{2}.477\right]=.602-2+.477$

$\log\frac{x}{m}=-.921=-1+1-.921$

$\log\frac{x}{m}=\bar{1}.079$

$\frac{x}{m}=\text{anti}\log\left(\bar{1}.079\right)=11.99\times10^{-2}g=12$

6.(A) Lyophilic colloid — Protective colloid

Emulsion — Liquid – liquid solution

Positively charged colloid — $FeCl_3+$ hot water

Negatively charged colloid — $FeCl_3+NaOH$

7.(9960)

$\frac{x}{m}=\frac{2\text{ gm }H_2}{2.5\text{ gm Pt}}=\frac{1\text{ mol}}{2.5\text{ gm Pt}}=0.4$ mole H_2 per gram Pt

$= \frac{0.4 \times 0.083 \times 300}{1}$ L Per gm Pt = 9960 mL per gm Pt

8.(B) It is sodium salt of stearic acid. It is not detergent. It is soap.

9.(C) Micelle formation occurs above a certain concentration known as CMC.

10.(B) Factual (follow NCERT)

11.(C) Statement (I) : (Correct) - Fact

Statement (II) : (Incorrect) - The principle emulsifying agents for oil in water emulsions are proteins, gums natural and synthetic soaps etc.

12.(2) Mass of acetic before adsorption

$0.2 = \frac{w_1}{60} \times \frac{1000}{2000}$

$w_1 = 2.4g$

Mass of acetic acid after adsorption

$0.1 = \frac{w_2}{60} \times \frac{1000}{200}$

$w_2 = 1.2\,g$

Mass of acetic acid adsorption

$w_1 - w_2 = 2.4 - 1.2 = 1.2\,gram$

Mass of acetic adsorption per gram of carbon $= \frac{1.2}{0.6} = 2$

13.(A) Lower the value of critical temperature lesser the gas will adsorb.

14.(A) Albumin of egg contains proteins that mix with water on stirring, hence it forms lyophilic sol.

15.(3) $\frac{x}{m} = KP^{1/n}$

$\log\frac{x}{m} = \log K + \frac{1}{n}\log P$

According to these equations.

Curve (a), (b) and (c) are not in accordance with Freundlich adsorption isotherm.

16.(A) An inhibitor blocks action of an enzyme by forming strong covalent bond with active site of the enzyme.

17.(C) Enzyme inhibitors can be competitive inhibitors (inhibit the attachment of substrate on active site of enzyme) and non-competitive inhibitor (changes the active site of enzyme after binding at allosteric site).

18.(C) Assertion (A) is true

Dissolved substances can be removed from a colloidal solution by diffusion through a parchment paper. Colloidal particles can not pass through parchment paper.

19.(C) Sodium rosinate enhanies the lathering property of soap.

20.(C) A is correct but R is not

SO_2 is adsorbed by activated charcoal more readily than CH_4 because gases with higher critical temperature are more liquefiable and will be adsorbed more readily.

21.(A) The color of colloidal solution depends on the wavelength of the light scattered by the colloidal particles which in turn depends on the size and nature of the colloidal particle.

Finest gold sol is red in color, as the size of the particle increases, it appears purple, then blue and finally golden.

Hence both Assertion and Reason are correct and R is correct explanation of A.

22.(D) Non-ionic detergents are formed by reaction between

$CH_3(CH_2)_{16}COOH + HO(CH_2CH_2O)_n CH_2CH_2OH$

$\downarrow -H_2O$

$CH_3(CH_2)_{16}COO(CH_2CH_2O)_n CH_2CH_2OH$

23.(A) ΔH can be positve or negative while ΔS is positive for Micelle formation.

24.(C) Factual

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1.(AD) **(B)** Enthalpy change during physisorption lies around (20 – 40) kJ/mole

(C) Chemisorption is an exothermic process